

Clothes-moths of the *Tinea pellionella* complex : a revision of the world's species (Lepidoptera : Tineidae)

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Synopsis

This paper gives an account of the eleven species of the *Tinea pellionella* complex, the case-making clothes-moths. One species is described as new. Nine new specific synonyms are established. Keys and figures for the identification of male and female specimens are given and special reference is made to intraspecific variation. The biology and distribution of each species is discussed in detail with special reference to damage, pest status and the factors limiting distribution. An extensive review of all literature including literature on control is provided: the bibliography contains 360 references. Records of outbreaks of introduced species and records of quarantine interceptions are given: distribution maps are provided.

Introduction

'The Motte bredethe amonge clothes till that they have byten it asonder; it is a maniable worm yet it hydeth him in y clothe that it can scantly be sene; it bredeth gladly in clothes that have ben i[n] an evyll ayre or in a rayn or myst & so layde up without hanging in the sonne or other swete ayre after. The [h]erbes that be bitter and well smelli[n]ge is good to be layde amo[n]ge suche clothes, [such] as the baielevis [or] cipreswode.'

(Anonymous, 1521)

Five Biblical references in which the clothes-moth appears in the context of simile or metaphor attest to the antiquity of man's awareness of – and opposition to – a ubiquitous group of pest species. Apart from appearances as a literary device (Job 14: 2, Isaiah 50: 9, 51: 8, Matthew 6: 19, James 5: 2) the clothes-moth was described in some detail by Plinius Secundus (*Historia Naturalis* 11: 41) in about A.D. 77 and, in one of the first printed books, Joannes de Cuba (1491) describes 'Tynea' and provides a woodcut (republished by Hartnack, 1939) of a woman brushing

larvae and frass from moth-eaten garments. A pirated version of Cuba's woodcut accompanies the earliest printed English account of the clothes-moth, quoted above.

Recognition of different 'Tynea' was not slow in evolving. Réaumur (1737) differentiated between the tapestry-moths (*Trichophaga* spp.) – which have free-living larvae – and the case-making species. Linnaeus (1758) described the common European tapestry-moth as *Phalaena (Tinea) tapetzella* and the case-maker as *Phalaena (Tinea) pellionella* – his *Phalaena (Tinea) vestianella* is not a clothes-moth as was shown recently by Sattler & Tremewan (1978). Linnaeus apparently did not recognize the webbing clothes-moth (also with a free-living larva) and it was not for a further eighty years, until the publication of a detailed review of the problem by Zeller (1838), drawing heavily on Réaumur's observations, that the separation of tapestry-moths (*Trichophaga*), webbing clothes-moths (*Tineola*) and the case-making clothes-moths (*Tinea*) was unequivocally established. The realization that '*Tinea pellionella*', the case-making clothes-moth, was really a complex of several species was gradual rather than sudden. Haworth recognized *flavescentella* as distinct from *pellionella* in 1828 and by 1860 *murariella* and *dubiella* had also been described. However, close similarities between the species of the *pellionella*-group had already caused a good deal of confusion and were to cause much more. Stainton (1874) reneged on his recognition of *dubiella* in precisely the same way as Müller-Rutz did some fifty-eight years later in deciding there was no genitalic difference between *turicensis* and *pellionella*; as it transpired, both were wrong. Improved optical equipment and dissection techniques permitted Pierce & Metcalfe (1934) to separate the tangle of specific identities known as '*flavescentella*' and (earlier) '*merdella*'. A review of the Palaearctic Tineidae by Petersen (1957) was closely followed by a volume of *Fauna SSSR* on the Tineinae (Zagulajev, 1960). However, even these last two works contained enough misidentifications to hamper seriously anyone using them (Petersen corrected many of these in a subsequent series of papers) and, being regional monographs, they were incomplete. Until a translation of Zagulajev's (1960) work was published (1975), no modern taxonomic work dealing with the species of the *pellionella*-group was available in English. Regrettably, the degree of accuracy of this translation is not high and large parts of the descriptions of at least two *pellionella*-group species have been omitted.

This paper is a revision of the case-making (or 'case-bearing') clothes-moths of the *Tinea pellionella* group. It does not include *Tinea pallescentella* Stainton nor *Tinea columbariella* Wocke for although both of these species have case-making larvae (*pallescentella* only makes a case when it is about to moult and leaves it when its new integument is hardened) they are not members of the *pellionella*-group. *Tinea pallescentella* was not collected in Europe until after 1840 and is now known from Patagonia, the U.S.A., Europe and New Zealand. Its appearance in western Europe coincided with the peak of the trade in salted sheepskins imported from Patagonia and I consider it to be a Patagonian species which has become established in Europe during the last 140 years. The taxonomic affinities of *pallescentella* are with Neotropical rather than Palaearctic species. Descriptions of *pallescentella* and *columbariella* (a species usually associated with birds' nests and rarely a pest) are given by Petersen (1969) and Zagulajev (1960) (the latter author misidentified *pallescentella* as *coacticella* Zagulajev). Only a few other species of Tineidae with case-making larvae are occasionally found associated with woollen or feather products – these are free-living *Monopis* species and their larval 'cases' are not true cases but immovable sections of tunnel, the walls of which consist predominantly of frass and food particles.

The eleven species of the *pellionella*-group described here correspond to the subgenus *Tinea* (as defined by Zagulajev – 1960 – in his classification of the Tineinae of the U.S.S.R.). However, several more species are included here and *Tinea pallescentella* (included by Zagulajev as *coacticella*) is excluded. The *pellionella*-group as here defined should not be interpreted as a subgenus although I consider it to be a monophyletic group. Six of the constituent species are known to be pests but the other five are rare and are not known to cause 'domestic' damage.

The identification of members of the *pellionella*-group is not possible without careful dissection of the genitalia of either sex. Although *steueri* may be recognized by its hyaline spot at the base of the fore wing, the remaining species are remarkably similar in appearance. The separation of females of *translucens* and *murariella* is difficult and one cannot expect to identify all specimens with certainty. A good stereoscopic microscope with a linear magnification range to at least

$\times 50$ is required for dissection and a good single-objective microscope with a magnification of up to $\times 500$ is required for the subsequent examination of preparations. The use of phase-contrast in the examination of certain specimens may be helpful.

In preparing this revision I have relied heavily upon specimens in the BMNH collection and, unless otherwise stated, all material examined is from that institution. In addition to approximately 950 specimens in BMNH, all *pellionella*-group specimens in NMNH, Washington (about 60 specimens) have been examined. Palaearctic material from many European institutions has been examined and published upon by Dr G. Petersen in a series of papers from 1959 to 1973. Specimens from the Ethiopian region have been assiduously searched out and published upon by Dr L. A. Gozmány (see Gozmány & Vári, 1973). It has therefore been possible to be unusually selective in choosing material for examination or re-examination.

The bibliography is intended to provide a practically complete listing of citations for all species. *Tinea pellionella*, however, is recorded in practically every local list ever published in Europe and it has also been misidentified by many workers. Local check-lists which, of the *pellionella*-group species, list only *pellionella* and are of little or no interest have been omitted from the bibliography in order to keep it to a manageable length. Each reference is followed by square brackets containing details of the contents of the cited work: absence of these details indicates that the item is of minimal interest. Where a geographical record is provided, the region involved is given, e.g. [Dalmatia].

Beneath each species heading, the valid name and its synonyms are given in chronological order of description with dates, reference to the original description and with the data and depository of the primary type or syntype series. This is followed by listings of subsequent literature citations of the valid name and of synonyms, again in the order of date of the original descriptions. Misidentifications are then listed (in square brackets) in sequence of date of their first occurrence.

Size measurements given are the wing span of a specimen set in conventional fashion.

The terminology used in descriptions of male and female genitalia follows Klots (1956) (see also 'Preparatory Techniques').

Low-power drawings were made using a camera lucida on a Wild M5 microscope. The scale lines on all these drawings are of 1 mm. High-power drawings of the apex of the aedeagus (Figs 14–27) and anellus spines (Figs 28–42) were made with a drawing attachment on a Wild M20 microscope and these drawings have scale lines of 0.1 mm. The number given in a smaller type-face on each drawing is the number of the wing or genitalia slide from which the drawing was made.

Preparatory techniques

Methods used for the preparation of genitalia slides are described elsewhere (Robinson, 1976*b*) and little modification of the techniques described in that paper is necessary in dealing with species of the *pellionella*-group. It is necessary, in the case of males, to protrude the aedeagus by holding it at the base and pushing it towards the uncus. This manoeuvre everts the anellus and exposes the anellus spines without entangling them with the tip of the aedeagus. The aedeagus may then be removed by holding it just below the apex and gently and carefully pulling it posteriorly. Removal of the aedeagus in an anterior direction results in damage to the anellus and the obscuring of details at the tip of the aedeagus by the anellus spines (see 'Morphology'): preparations made in this way are extremely difficult to examine satisfactorily or to identify without the use of phase-contrast microscopy. The male genital armature is laterally compressed and difficult to mount in a dorsoventral position. The uncus, gnathos and anellus spines are best examined in lateral view and the preparations for this work were therefore mounted with the left valve folded down towards the saccus, the genital armature in lateral (Fig. 13) or three-quarter view with the aedeagus removed and mounted separately.

The female genitalia must be removed from the abdomen and the contents of the corpus and ductus bursae removed before adequate examination can be carried out.

Chlorazol Black E or mercurochrome was used for staining preparations and Euparal was employed as a mounting medium.

Abbreviations

BMNH	British Museum (Natural History), London, U.K.
IP	Institut für Pflanzenschutzforschung, Eberswalde, East Germany.
MAK	Zoologisches Forschungsinstitut und Museum Alexander Koenig, Bonn, West Germany.
MARC	Mt Albert Research Centre, Auckland, New Zealand.
MNHN	Muséum National d'Histoire Naturelle, Paris, France.
MNHU	Museum für Naturkunde der Humboldt-Universität, Berlin, East Germany.
MRAC	Musée Royal de l'Afrique Centrale, Tervuren, Belgium.
MZU	Museum of Zoology of the University, Oulu, Finland.
NM	Naturhistorisches Museum, Basle, Switzerland and Vienna, Austria.
NMNH	National Museum of Natural History, Washington, D.C., U.S.A.
P.	Slide number prefix for Pierce slide collection, BMNH.
Pet.	Slide number prefix for preparation by G. Petersen.
TM	Természettudományi Múzeum, Budapest, Hungary.
UM	University Museum, Oxford, U.K.
UOP	University of Osaka Prefecture, Osaka, Japan.
UZI	Universitetets Zoologiska Institution, Lund, Sweden.
ZI	Zoological Institute, Academy of Sciences, Leningrad, U.S.S.R.
ZMU	Zoological Museum of the University, Helsinki, Finland.

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The photographs of moths, larval cases and pupae (Figs 82–103) were produced by the Photographic Unit, BMNH.

Check-list of the species of the *Tinea pellionella* group

Tinea Linnaeus, 1758

Autoses Hübner, [1825]

Dystinea Börner, 1925

flavescentella Haworth, 1828

**tristigmatella* Costa, [1836]

roesleri Gozmány, 1969

pellionella Linnaeus, 1758

**zoolegella* (Scopoli), 1763

**albella* Costa, [1836], nom. praeocc.

demiurga Meyrick, 1920, syn. n.

gerasimovi Zagulajev, 1978, syn. n.

translucens Meyrick, 1917

metonella Pierce & Metcalfe, 1934, syn. n.

**leonhardi* Petersen, 1957, syn. n.

margaritacea Gozmány, 1967, syn. n.

fortificata Gozmány, 1968, syn. n.

murariella Staudinger, 1859

bipunctella (Ragonot), 1874

- lanella* Pierce & Metcalfe, 1934
messalina sp. n.
dubiella Stainton, 1859
 turicensis Müller-Rutz, 1920, syn. n.
 bispinella Zagulajev, 1960, syn. n.
 tenerifi Zagulajev, 1966, syn. n.
steueri Petersen, 1966
bothniella Svensson, 1953
 sibiriella Zagulajev, 1960
 unidentella Zagulajev, 1960
hongorella Zagulajev, 1975

* primary type or syntype not examined.

Geographical distribution

I consider the *Tinea pellionella* group to be of Old World origin, its present-day species originating in the northern hemisphere with the exception of *roesleri* which is an endemic Ethiopian species closely related to *flavescentella*. The distribution of many of the members of the *pellionella*-group has been and is being modified, not only by the transport of specimens by man (e.g. *dubiella* and *pellionella* to Australia and New Zealand, *murariella* to the neotropics) but also by alteration of their environment. The spread of central heating in buildings in temperate western Europe has apparently resulted in the decline of *pellionella* as a pest while a species less resistant to cold (*translucens*) has been able to colonize this new 'tropical' environment, albeit in sporadic outbreaks as a result of importation (see below).

Distribution maps are given for the commoner species of the *pellionella*-group (Figs 76–81) and it will be seen that distributions range from Palaearctic-Subarctic (*bothniella*) and Palaearctic-European-Mediterranean (*flavescentella*) to practically cosmopolitan (*dubiella*, *translucens*, *pellionella*). Maps are not given for species known only from one or two localities.

Geographic variation of a minor nature has been noted in *translucens* (minor differences between Japanese specimens and those from other localities) and in *flavescentella* (minor differences in two male specimens from Spain and North Africa) – see the descriptions for these species. In *translucens* variation is restricted to the male.

A paucity of records of the *pellionella*-group from the New World and the Indo-Pacific region may be attributable to under-collection. The Neotropical region has, however, a rich tineine fauna and niches for keratin-feeders may already be filled by species other than those of the *pellionella*-group. *Tinea pallescentella*, considered to be originally a Neotropical species which has recently colonized other regions and fills a *pellionella*-group niche, has a number of relatives which, with *pallescentella*, may form the Neotropical equivalent of the *pellionella*-group; a small group of endemic *Tinea* species with Neotropic affinities is also present in the Nearctic region and this too may block the spread of *pellionella*-group colonizers.

Morphology

The morphology of the structures used in identification of the *pellionella*-group is unremarkable with the exception of that of the aedeagus which has misled a number of authors. The aedeagus lies, after maceration, in an invaginated membranous tube – the anellus. Manoeuvring the tip of the aedeagus towards the uncus, the anellus may be evaginated to expose the pair of lateral bands of anellus spines (Fig. 13) which, when the aedeagus is retracted, overlie the tip of the aedeagus. The aedeagus is tubular and sclerotized to the tip but the sclerotization may continue in a short 'tongue' which may be invaginated with the vesica (this is shown in Fig. 17). The apical or subapical sclerotized wall of the aedeagus may have thorn-like projections (e.g. *pellionella*), spines (e.g. *flavescentella*) or comb-shaped projections (*lanella*). These sclerotized projections, continuous with the sclerotized wall of the aedeagus, are carinae (see Klots, 1956) and are not

to be confused with sclerotized attachments to the unsclerotized membrane of the vesica which are cornuti. Cornuti are either inside or projecting from the tip of the aedeagus – unless the vesica is partially or wholly everted. Examination of copulas has shown that in the *pellionella*-group the vesica is only slightly everted to the degree shown in Figs 19, 24 and 25. Several authors (e.g. Petersen, 1966; Gozmány & Vári, 1973) have confused anellus spines, carinae and cornuti and subsequent identification from their drawings or descriptions is extremely difficult.

In the case of *Tinea translucens*, the group of needle-like apical cornuti may arise from a membranous surround (Fig. 18) or from a sclerotized extension of the aedeagus wall (Figs 19, 20) and this individual variation makes it impossible to label unequivocally the apical spines as either cornuti or carinae in this species. They are here referred to as the former but no significance should be attached to this choice of term.

In the figures of the aedeagus given here (Figs 14–27) the membrane of the vesica is not shown within the aedeagus and the figures should be interpreted with the description of the male genitalia.

Variation in venation, valva shape, length of aedeagus and saccus and in the number of signa is discussed in some detail below (see 'Remarks' for the *Tinea pellionella* group).

TINEA Linnaeus

Tinea Linnaeus, 1758, *Syst. Nat.* (edn 10) 1: 496. Type-species: *Phalaena (Tinea) pellionella* L., 1758, *ibidem* 1: 536, by subsequent designation by ICZN, 1957, *Opin. Decl. int. Comm. zool. Nom.* 15: 254. *Autoses* Hübner, [1825], *Verz. bekannter Schmett.*: 401. Type-species: *Phalaena (Tinea) pellionella* L., 1758, *Syst. Nat.* (edn 10) 1: 536, by subsequent designation by Fletcher, 1929, *Mem. Dep. Agric. India, Ent. Ser.* 11: 29.

Dystinea Börner, 1925, in Brohmer, *Fauna Dtl.* (edn 3): 372. Type-species: *Phalaena (Tinea) pellionella* L., 1758, *Syst. Nat.* (edn 10) 1: 536, by original designation.

As currently constituted, the cosmopolitan genus *Tinea* contains over 400 nominal species, many of which are not Tineinae. It is therefore impracticable to give a generic diagnosis which defines the limits of the genus.

The *pellionella*-group

♂, ♀. 8–17 mm. Head with conspicuous pair of large tufts of elongate scales forming rosettes behind eyes and extending forward to vertex; frons with more diffuse pair of similar tufts; scale insertions extending anteriorly from base of antenna to a third pair of tufts just posterior to tentorial pits. Pilifers short, stout, clothed with elongate dark bristles. Maxillary palpus five-segmented, clothed with closely appressed pale scales, reaching to between middle of second segment of labial palpus and middle of third segment. Fourth segment of maxillary palpus elongate, at least twice length of any other segment; fifth segment shortest, one-quarter or less length of fourth segment. Labial palpus three-segmented, length of first, second and third segments approximately in proportion 3:5:4. Second segment of labial palpus with line of rough, protuberant scales on ventral surface and with ventral row of about ten elongate dark bristles; outer side of second segment with similar but more sparse row of six or seven bristles; apex of second segment with half-rosette of eight to ten bristles on outer side. Galea short, not reaching tip of first segment of labial palpus (*flavescentella* and perhaps *roesleri*) or twice that length, reaching middle of second segment. Antenna filiform, scape with pecten of eight to ten deciduous bristles, pedicel slightly swollen. Segments of flagellum short, cylindrical or barrel-shaped, finely ciliate, cilia not as long as segment diameter; each segment clothed with closely appressed elongate scales. Fore wing elongate, ovate (Figs 3–7) with complete venation (Fig. 3) or venation modified by stalking (Figs 4–7) or development of M_4 (Fig. 7 – see also *hongorella*). Venation variable (especially in position of branching of veins from cell – compare Fig. 5 with 6), both within and between species. Fore wing yellowish or brownish with characteristic pattern of three dark dots, discocellular, discal and plical (absent or ill-defined in *bothniella* and *hongorella*). Hind wing venation complete but variable within and between species particularly with respect to configuration at end of cell (Figs 8–12). Female with two frenulum bristles. Hind wing glossy, pale greyish or ochreous.

GENITALIA ♂ (Fig. 13). Saccus narrow, elongate. Valva triangular to rectangular, apex rounded or truncated at costal margin, shape variable within and between species; valva without protruding lobes or processes of any kind (Figs 43–49). Juxta roughly hexagonal, usually only lightly sclerotized, sclerotization continuous with vinculum. Gnathos tapered, directed postero-ventrad, tips more or less upturned towards

uncus, shape of dorsal margin varying from straight to concave both within and between species. Uncus stout, tapered, turned slightly ventrad (markedly hooked ventrad in *steuerei* and *bothniella*) and with a distinctive small notch in the tip. Anellus with band of heavily sclerotized spines at either side of aedeagus, spines strongly developed closest to vinculum and becoming smaller and less heavily sclerotized towards tip of anellus; distal to smallest spines, band usually still visible as row of progressively weaker sclerotized plaques. Anellus spines, usually numbering about 20, arranged in a band three or four spines wide but spines sparse in *lanella* and very large and arranged in single line in *bothniella* and *steuerei*. Aedeagus cylindrical, straight or slightly curved, with minute thorn-like carinae just below apex (*pellionella*, *hongorella*), with spine-like carinae at apex (*flavescentella*, *roesleri*), with a serrated, comb-shaped pair of carinae below apex (*lanella*) or without carinae. Vesica with a single small (*flavescentella*) or large (*bothniella*) cornutus, without cornuti (*hongorella*, *steuerei*), or with a pair of elongate blade-shaped cornuti which may be substantially reduced (*dubiella*) and may be accompanied by smaller cornuti (*translucens*, *messalina*).

GENITALIA ♀. Eighth sternite with deep medial emargination accommodating ostium. Antrum swollen posteriorly, inner wall with or without transverse folds or dish-shaped protuberances (*dubiella*). Anterior region of antrum with or without (*steuerei*) pair of more or less heavily sclerotized lateral longitudinal folds which may be transversely divided into two sections with differing degrees of sclerotization and membrane thickness and hence different staining properties. Some species with pattern of annular sclerotization at posterior end of ductus bursae, adjacent to antrum, appearing as fine, dark transverse stripes. Inception of ductus seminalis dorsal, immediately anterior to antrum and to any annular sclerotization. Corpus bursae with one to six signa. Signa needle-like, each set in nodular, pyramidal or short and blade-shaped sclerotized base which may, in turn, lie in large circular sclerotized field hereafter referred to as the 'signum base-plate'. Signa in equatorial or anterior position on wall of corpus bursae.

REMARKS. A number of characters have, during this study, been found to be subject to marked intraspecific variation. Zagulajev (1960) has laid much stress upon venational characteristics and has used these extensively in his key to the species of *Tinea* occurring in the U.S.S.R. As in the Tinissinae (Robinson, 1976a), the venation of the *pellionella*-group was found to be markedly unstable. The fore wing shows particular instability (Figs 3–7) with respect to the separation or otherwise of R_4 and R_5 , the comparative distance between the bases of R_1 and R_2 and R_2 and R_3 , the configuration of the discocellular cross-vein and the bases of the veins which arise from it. The degree of development of the discal chorda, M in the cell and of CuP are also variable. In the hind wing (Figs 8–12) the configuration of the discocellular cross-vein and attached vein-bases is variable as is the degree of development of M and CuP . The position of the tip of M_1 in relation to the wing apex is not of significance at species level as suggested by Zagulajev (1960). The development of 'extra' veins is by no means rare; a supernumerary vein may be present as a result of forking of R_s (Fig. 11) or by the addition of a medial branch (M_4) in the fore wing as in the holotype of *Tinea hongorella* (q.v.) or the specimen of *Tinea translucens* in Fig. 11.

I have been unable to find venational characteristics which serve to differentiate between the species of the *pellionella*-group recognized here. It is noteworthy that Zagulajev's key (based on external characteristics and placing heavy reliance on venation) for the separation of the species of *Tinea* found in the U.S.S.R. (1960: 144) contains two pairs of misidentifications, each pair representing the opposite sexes of one species. These pairs are *leonhardi* + *turicensis* (= *translucens*) and *unidentella* + *sibiriella* (= *bothniella*). The first pair is separated by venational characteristics, the second pair by the length of the maxillary palpi; the second pair is later (p. 172) differentiated by venation. Within the *pellionella*-group the length of the maxillary palpi does not differ consistently between species. In *steuerei* and *bothniella*, however, the palpi may be longer than in the other species but more material is needed before this can be verified. There appears to be no difference in the length of the maxillary palpi of the opposite sexes of the same species.

Zagulajev (1960: 146) has used the ratio of aedeagus length to saccus length and also the ratio of the length of the aedeagus to that of the valva as key characters. The shape of the valva varies considerably both within and between species of the *pellionella*-group (Figs 43–49) and does not appear to offer any greater stability in length than the saccus; in addition it is difficult to measure the length of the valva with any degree of accuracy. I have taken graticule measurements of the aedeagus and saccus length of each undamaged male genital armature examined, a total of 160 pairs of measurements. A scatter diagram (Fig. 1) of the measurements shows there to be much

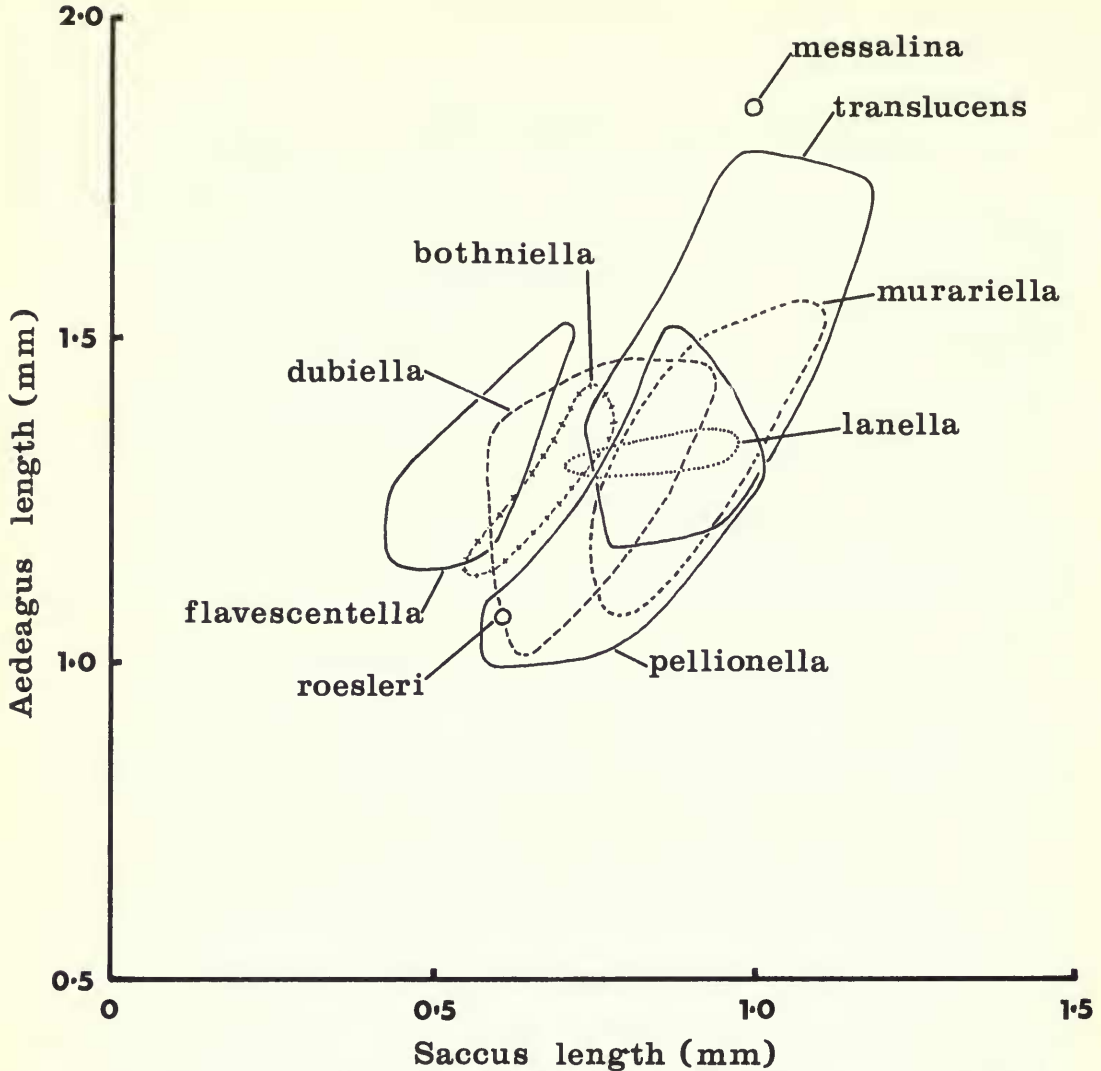


Fig. 1 Outlines of scatter diagrams of aedeagus length plotted against saccus length for nine species of *Tinea*. Number of points plotted for each species – *flavescentella*, 15; *roesleri*, 1; *pellionella*, 59; *translucens*, 35; *murariella*, 12; *lanella*, 3; *messalina*, 1; *dubiella*, 28; *bothniella*, 4. (Original data are available from the author on request.)

overlap of all species [measurements from *steuerei* and *hongorella* are not included – but see the description of the male genitalia of these species] with the exception of *flavescentella* (short saccus) and *messalina* (long aedeagus). *Tinea dubiella* and *bothniella* fill the gap in saccus size between *flavescentella* and the rest of the species here considered. The means and 95% confidence limits for aedeagus and saccus length and the ratio of the two are given in the description of the ♂ genitalia of each species.

Intraspecific variation occurs also in the shape of the valva, notably in its size, the degree of concavity of the costa and the degree of truncation at the costal side of the apex (Figs 43–49).

In the female genitalia, the most pronounced variation occurs in the number of signa (Fig. 2). Variation may be extreme and common (*pellionella* has from two to five signa) or may never occur (all specimens of *translucens* examined were found to have two signa) or may be of an intermediate nature (*flavescentella* usually has four signa but may very occasionally have two or three).

Some slight variation may occur in the size and location of signa in all species but the greatest range of variation occurs in *pellionella* in which a 'basic complement' of two signa is augmented by up to three further signa which may be considerably smaller than the 'basic' pair and may not be set in sclerotized base-plates. Minor variation also occurs in the configuration of the antrum (Figs 58–66).

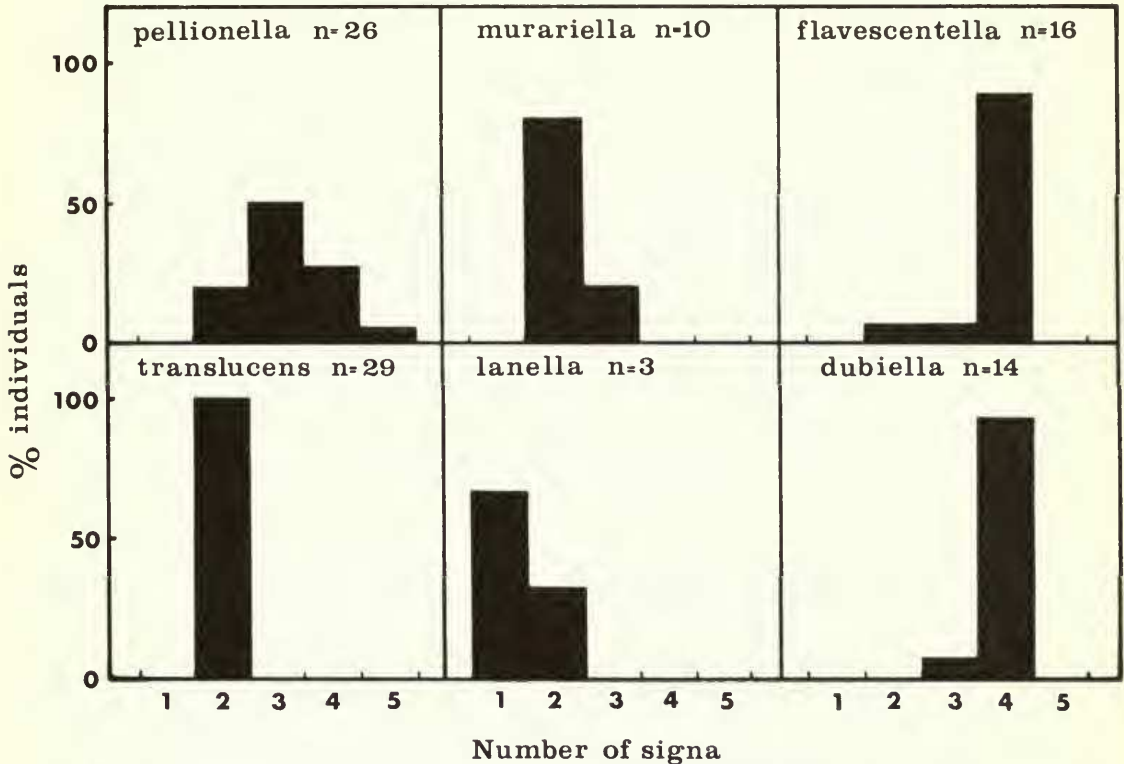


Fig. 2 Histograms of number of signa found in females of six species of *Tinea*. n = number in sample. (Original data are available from the author on request.)

BIOLOGY. The *Tinea pellionella* group includes all the species currently recognized as case-making clothes-moths (with the exception of *T. pallescentella* – see above) and these species are capable of utilizing most forms of keratin as a foodstuff. The list of domestic and industrial materials fed upon by the *pellionella*-group includes wool, fur, feathers, leather, silk, fish-meal and hooves and probably also horn (of which *Ceratophaga* spp. are the major pests). Where not associated with man, larvae of case-making clothes-moths are found feeding in keratin sources such as animal corpses, birds' nests, bird-pellets, mammal burrows and weathered carnivore faeces.

Case-making clothes-moths occupy climatic zones from subarctic (*bothniella*) to sub-desert (*murariella*) and humid tropical (*translucens*). The life-cycle and its timing is dependent upon temperature. Species developing in cold localities with a prolonged winter are univoltine (*bothniella*) while others in warmer environments are bivoltine (*dubiella* at low latitudes) or continuous-brooded (*translucens* in centrally heated houses or in the tropics). The timing of the life-cycles of different species at abnormally high temperatures (see *pellionella*, *murariella* and *translucens*) is very similar and the factors limiting distribution are, I believe, coldness and dryness. Curiously, no investigations have been made of the tolerance to low temperatures of members of the *pellionella*-group. The upper temperature limits of *murariella*, *pellionella* and *translucens* have been investigated (Cheema, 1956; Chauvin, 1977) and they seem to be similar and not to account for

distribution. Further details of the biology and a bibliography of biological literature are given below for each species.

The larvae of the species of the *pellionella*-group are all (where known) case-makers, using particles of the food substrate and quantities of silk to produce a flattened case (Figs 102, 103) in which the larva lives. The shape and method of construction of the case is similar in all the species examined. Larvae pass through a minimum of five instars and when fully grown climb away from the food source and suspend themselves and their case from a (usually) horizontal surface; pupation occurs within the larval case and, shortly before emergence, the pupa protrudes itself from the case using the backward-pointed abdominal spines to work the head and thorax clear of the larval case (Figs 102, 103).

Several members of the *pellionella*-group, notably the pest species, have been recorded as having been transported by man as a result of trade, notably trade in wool, fur and hides. The populations of *pellionella*-group species in Australia and New Zealand are the result of importation and it is likely that the recent 'bongo-drum' outbreaks of *translucens* (q.v.) in Britain have their origins in individual infestations beginning in East or southern Africa.

At least four species have been successfully reared in the laboratory – *dubiella*, *murariella*, *translucens* and *pellionella*. Wakely (1962) reared *dubiella*; the other three species have been reared by me and by Chauvin (many papers – see bibliography). Chauvin rears his material on the skins of small mammals, keeping his cultures at 20–25 °C. My cultures are maintained at similar temperatures but are fed with wool (strips of old woollen clothing) sprinkled with fish-meal mixed with 10% dried yeast powder. Both *translucens* and *murariella* thrive under these conditions but the culturing of *pellionella* has so far proved to be very difficult: Chauvin (*pers. comm.*) also reports *pellionella* to be difficult to rear under artificial conditions. Few papers deal with the rearing of Tineidae but that by Billings (1936) is helpful.

PARASITES. Hymenopterous parasites of '*Tinea pellionella*' are recorded by Riley (1890–1), Marlatt (1915), Brèthes (1920), Nagamori (1925), Bruneteau (1930), Morley (1930), Voukassovitch & Voukassovitch (1931), Watanabe (1932), Morley & Rait-Smith (1933), Ferrière (1941), Burks (1943), Thompson (1947), Mason (1948), Richards (1949), Woodroffe & Southgate (1951*a*) and Nixon (1976). I consider that the host recorded as '*pellionella*' by Brèthes (1920) is *murariella* as this is the only species of the *pellionella*-group known from the eastern Neotropical region. Similarly, the '*pellionella*' of Nagamori (1925) and Watanabe (1932) is considered to be *translucens*. The remainder of the literature records are considered to refer correctly to *pellionella*. Of the parasite names used by the above authors, *Metacoelus mansuetor* Gravenhorst and *Hyperacmus tineae* Riley are now considered to be junior synonyms of *Hypsicera curvator* (F.) (Ichneumonidae), *Tetrastichus carpatus* Burks is a junior synonym of *T. tineivorus* Ferrière (Chalcidae), *Apanteles igae* Watanabe is a junior synonym of *A. carpatus* (Say) (Braconidae) and *Paramesocrina tineavora* Nagamori is a junior synonym of *Chremylus rubiginosus* (Nees) (Braconidae). According to Dr Z. Bouček (*pers. comm.*), the species of *Habrocytus* which in the experiments of Voukassovitch & Voukassovitch (1931) was found to attack *pellionella* is not *saxesenii* but very likely *H. semotus* (Walker) (Pteromalidae). During this study, *Hypsicera curvator* (F.) (Ichneumonidae) has been reared from *Tinea translucens* and Latvian specimens of *pellionella* and their associated parasites (collected by Lienig) have been found; the parasites were identified by Dr M. G. Fitton as *Gelis cinctus* (L.) (Ichneumonidae).

Predators of larvae include *Scenopinus fenestralis* (L.) (Diptera: Scenopidae) (Rothschild & Clay, 1952) and a spider (Key & Common, 1959).

The recorded parasites of the species of the *pellionella*-group are, in many cases, cosmopolitan and not restricted to feeding on larvae of case-making clothes-moths but are recorded from a number of species of Lepidoptera with small, case-making larvae. It is likely that parasites have been and are transported by man along with their hosts. There is no suggestion, from the lists of parasites given below, that any host-specificity is to be found among the parasites of the *pellionella*-group.

Lists of parasites are given below for each species for which records are available – *pellionella*, *translucens* and *murariella*.

Key to males

- 1 Tip of aedeagus with 4–8 spine-like carinae at apex (Figs 26, 27); saccus usually less than 0.60 mm long 2
- Tip of aedeagus without carinae or, if present, carinae not apical and spine-like; saccus usually more than 0.60 mm long 3
- 2 Aedeagus with two distorted blade-shaped cornuti (Fig. 27) *roesleri* (p. 71)
- Aedeagus with one small, slender cornutus (Fig. 26) *flavescentella* (p. 68)
- 3 Anellus spines large, arranged singly in a row (Figs 68, 69) 4
- Anellus spines small, arranged in a row at least three spines wide (Figs 28–42) 5
- 4 Spots in fore wing well-defined; base of costa with elongate hyaline spot; aedeagus without cornutus *steuerei* (p. 91)
- Spots in fore wing absent or ill-defined; base of costa without elongate hyaline spot; aedeagus with single strong cornutus (Fig. 67) *bothniella* (p. 92)
- 5 Vesica without cornuti; carinae thorn-like, arranged longitudinally down sclerotized bars on either side of aedeagus *hongorella* (p. 94)
- Vesica with pair of large blade-shaped cornuti or pair of reduced apical or subapical cornuti 6
- 6 Aedeagus with only two reduced apical or subapical cornuti which are not as long as aedeagus is wide *dubiella* (p. 88)
- Aedeagus with pair of strongly-developed blade-shaped cornuti which are longer than aedeagus is wide 7
- 7 Aedeagus with pair of large serrated carinae below apex (Fig. 25) *lanella* (p. 85)
- Carinae, if present, numerous, small and thorn-like 8
- 8 Vesica with at least four small cornuti usually protruding from tip of aedeagus (Figs 18–20) *translucens* (p. 79)
- No small cornuti protruding from tip of aedeagus; small cornuti, if present, are stout and situated at three-quarters length of aedeagus (as in Fig. 24) 9
- 9 Vesica with three small, stout cornuti at about three-quarters length of aedeagus (Fig. 24) *messalina* (p. 87)
- Vesica with pair of elongate, blade-shaped cornuti 10
- 10 Aedeagus with patch of small, thorn-like carinae either side of apex (Figs 14–16) *pellionella* (p. 72)
- Aedeagus without carinae (Figs 21–23) *murariella* (p. 83)

Key to females

[Females of *hongorella* are unknown]

- 1 Signa set in large, flat, circular sclerotized base-plates (Figs 50–52, 54) 2
- Signa set in unsclerotized membrane of corpus bursae (Figs 53, 55–57, 72, 75) 6
- 2 Anterior longitudinal folds of antrum without transverse division (Fig. 63) *messalina* (p. 87)
- Anterior longitudinal folds of antrum with transverse division (Figs 58–60) 3
- 3 Corpus bursae with four or five signa *pellionella* (part) (p. 72)
- Corpus bursae with three or fewer signa 4
- 4 Anterior region of antrum more than half as wide as posterior (bulbous) region (Figs 50, 58); no annular sclerotization at anterior end of ductus bursae *pellionella* (part) (p. 72)
- Anterior region of antrum less than half as wide as posterior (bulbous) region (Figs 59, 60); with annular sclerotization at anterior end of ductus bursae 5
- 5 Longitudinal folds of antrum divided transversely in posterior half (Fig. 59); corpus bursae with two signa *translucens* (p. 79)
- Longitudinal folds of antrum divided transversely in anterior half (Fig. 60); corpus bursae with two or three signa *murariella* (p. 83)
- 6 Corpus bursae with more than five signa 7
- Corpus bursae with less than five signa 8
- 7 Antrum long and narrow (Fig. 65); fore wing with three dark dots *roesleri* (p. 71)
- Antrum short and broad (Figs 73, 74); fore wing without dots *bothniella* (p. 92)
- 8 Antrum wider than long (Fig. 66) *steuerei* (p. 91)
- Antrum longer than wide 9
- 9 Corpus bursae with one or two signa *lanella* (p. 85)
- Corpus bursae with three or four signa 10
- 10 Signa small (Fig. 55); antrum short (Fig. 62) *dubiella* (p. 88)
- Signa large (Fig. 56); antrum long (Fig. 61) *flavescentella* (p. 68)

Descriptions of species

Tinea flavescentella Haworth

(Figs 1, 2, 6, 8, 26, 37–39, 46, 56, 61, 76, 82, 83, 103)

Tinea flavescentella Haworth, 1828, *Lepid. Britannica* : 564. Lectotype ♀, [BRITAIN] (abdomen missing; UM, Oxford) designated by Bradley (1966b : 130) [examined].

Tinea tristigmatella O. G. Costa, [1836], *Fauna Regno Napoli*, Lepidotteri : [232], [312], pl. (Lep. Nott.) 4, fig. 8A. Type(s), ITALY: Naples [not found; not examined]. [Synonymized by Walsingham, 1907 : 268.]

Tinea flavescentella Haworth; Stephens, 1829a : 51 [catalogue]; Stephens 1829b : 224 [catalogue]; Curtis, 1831 : 187 [list]; Stephens, 1834 : 346 [description]; Curtis, 1837 : 214 [list]; Wood, 1839 : 225, pl. fig. 1558 [description; figure of adult]; Stainton, 1849a : 8; Stainton, 1852 : 11, 39 [date of appearance of imago]; Stainton, 1854b : 15 [*partim* – catalogue]; Doubleday, 1859 : 27 [list]; Wocke, 1861 : 107 [catalogue]; Walker, 1863 : 469 [catalogue]; Wocke, 1871 : 270 [distribution; bibliography; catalogue]; Merrin, 1875 : 242 [no life-history data]; Hartmann, 1879, 3 : 199; Lafaury, 1886 : 410 [larval description; biology – determination not verified]; Meyrick, 1895 : 791 [synonym of *pellionella*]; Rebel, 1901 : 238 [synonym of *pellionella*]; Dyar, [1903] : 527 [synonym of *pellionella*]; Crombrugge de Picquendaele, 1906 : 124 [synonym of *pellionella*]; Walsingham, 1907 : 268 [*partim* – bibliography, biology]; Waters, 1928 : 176 [bred from dead pigeon, Oxford]; Waters, 1929 : 58 [bred from dead pigeon, Oxford]; Pierce & Metcalfe, 1934 : 266 [genitalia]; Pierce & Metcalfe, 1935 : 95, pl. 58 [genitalia]; Walker & Hobby, 1939 : 105 [bred from dead pigeon, Oxford]; Corbet & Tams, 1943b : 111, 143, figs 231, 258, 286, pl. 5, figs 31, 32 [identification; distribution; biology]; Ford, 1949 : 184 [biology]; Bradley, 1953 : 18 (*partim* – 1 ♂ only) [Ireland]; Petersen, 1957 : 150, fig. 116 [♀ genitalia; Germany (West)]; Zagulajev, 1960 : 159 [description]; Petersen, 1962 : 208 [Dalmatia]; Petersen, 1963b : 414 [from birds' nests – doubtful record]; Lhomme, 1963 : 1101 [France – not verified]; Gozmány & Szócs, 1965 : 142, figs 36C [poor], 37C [key; genitalia figures]; Căpușe, 1968 : 331, figs 172A, 173A (*partim* – ♂ only) [Rumania]; Petersen, 1968 : 98 [Germany (West)]; Petersen, 1969 : 374, figs 153, 162, 170 [genitalia; biology; distribution; Germany (East)]; Hicks, 1971 : 178 [doubtful bird's nest record]; Bradley *et al.*, 1972 : 8 [checklist]; Hulme, 1972 : 184 [locality of P. B. Mason specimens probably Staffordshire]; Pallesen & Palm, 1973 : 104 [Denmark]; Hannemann, 1977 : 222, pl. 14, fig. 6, figs 122a–b [distribution (E. Germany); genitalia].

Tinea tristigmatella Costa; Zeller, 1847 : 808; Heydenreich, 1851 : 79 [list]; Stainton, 1869 : 267 [*T. pellionella* ?]; Curò & Turati, 1883 : 11 [consider of doubtful status and refer to Zeller]; Walsingham, 1907 : 268 [synonym of *flavescentella*]; Corbet & Tams, 1943b : 111 [probable synonym of *flavescentella*]; Petersen, 1957 : 150 [synonym of *flavescentella*]; Petersen, 1969 : 374 [synonym of *flavescentella*]; Hannemann, 1977 : 222 [synonym of *flavescentella*]; Tremewan, 1977 : 227 [synonym of *pellionella*].

[*Tinea merdella* Zeller; Stainton, 1859b : 293, 466; Horton, 1859 : 109 [larva]; Doubleday, 1859 : 27; Morris, 1870 : 24, pl. 99, fig. 14 [description; figure]; Stainton, 1874 : 3; Merrin, 1875 : pp. [life-cycle]; Barrett, 1878 : 269 [Pembrokeshire]; Kane, 1900 : 127 [Ireland]; Pyett, 1902 : 3 [Suffolk]; Bloomfield, 1902 : 7 [Suffolk – as '*merdella* Zett.' (sic)]; Walsingham, 1907 : 268 (*partim*). Misidentifications.]

[*Tinea metonella* Pierce & Metcalfe; Pierce & Metcalfe, 1934 : 266 (*partim* – 1 ♀ only). Misidentification.] [*Tinea pellionella* L.; Bradley, 1952 : 185 [Ireland]. Misidentification.]

♂ (Fig. 82). 8–12 mm. Head light fawn to cream. Maxillary palpus whitish, extending to just beyond second segment of labial palpus. Labial palpus cream, terminal segment with light brownish scales above and at sides. Galea very short, not reaching tip of first segment of labial palpus. Antenna brownish cream, almost reaching apex of fore wing. Thorax and tegula light fawn, speckled anteriorly with light brown scales. Fore wing light fawn, fringes concolorous, scales at base, posterior to fold and at termen slightly darker and more brownish. Discocellular, discal and plical spots pale creamy brown, large. Hind wing very light greyish brown, fringes paler. Legs cream, forelegs dusted above with pale brown. Abdomen light greyish brown.

♀ (Fig. 83). 11–17 mm. Coloration as ♂ but in some examples seen, vestiture of head darker and more reddish than in ♂ and ground colour of fore wing darker, light greyish brown.

GENITALIA ♂. Saccus very short, 0.51 ± 0.12 mm long. Valva (Fig. 46) with apex more or less slightly truncated at costal margin. Dorsal margin of gnathos straight, tips curved inwards towards tip of uncus. Anellus spines (Figs 30, 37–39) large and protuberant but not numerous [specimens from Spain and Algeria (Figs 30, 38) have broader band of slightly smaller spines than in specimens from Britain (Figs 37, 39)]. Aedeagus (Fig. 26) 1.25 ± 0.19 mm long; tip with seven or eight stout carinae [four in Algerian, five in Spanish specimen]; vesica with single cornutus of similar size and shape to carinae, usually located level with them. Aedeagus/saccus ratio 2.48 ± 0.48 .

GENITALIA ♀. Eighth sternite with broad U-shaped emargination (Fig. 61) with a more or less pronounced anterior nick. Antrum (Fig. 61) elongate, broadened posteriorly, with large lateral sclerotized patches; transverse folds pronounced; longitudinal folds sclerotized and conspicuous, not transversely divided. Corpus bursae (Fig. 56) with two to four densely sclerotized thorn-shaped signa grouped towards anterior end of corpus bursae; signa not set in sclerotized circular base-plates.

REMARKS. *Tinea flavescetella* is a distinctly pale-coloured species with larger and better-defined fore wing spots than in the other species here described. The male genitalia are remarkable in that the two blade-shaped cornuti present in most other members of the *pellionella*-group are lost in *flavescetella* and the saccus is very short. The shape, size and position of the signa in the female genitalia is diagnostic as is the characteristic broad and elongate antrum.

The specimens from Spain and Algeria included here differ slightly from other specimens examined in having fewer carinae on the aedeagus and a broader band of anellus spines. In addition, the Spanish specimen has a longer saccus and aedeagus (0.70 and 1.50 mm respectively) than other specimens of *flavescetella* examined. No significance can be attached to these differences without the detailed examination of further material of *flavescetella* from Spain and North Africa.

This is the '*Tinea merdella*' of nineteenth-century (notably British) authors (see Walsingham, 1907) but not of Cooke (1856) nor of Stainton (1857) (see below). Stainton's redescription of '*merdella*' has been generally assumed to be a misidentification of *flavescetella* (Walsingham, 1907, *et alii* including Petersen, 1957: 150). Stainton described Cooke's specimens in this work and Cooke's specimens include the lectotype of *Tinea metonella* Pierce & Metcalfe, a species here considered to be a junior subjective synonym of *Tinea translucens* Meyrick. Thus '*Tinea merdella*' *sensu* Stainton, 1857 [1856 *auctorum* – see below] is a misidentification and referable to *translucens* and not to *flavescetella*.

Tinea merdella Zeller has, as pointed out by Walsingham (1907), nothing to do with the case-making clothes-moths and was referred to the genus *Paratinea* by Petersen (1957: 159). Despite this, Zagulajev (1960: 159) erroneously placed *merdella* Zeller as a synonym of *flavescetella* Haworth along with *dubiella* Stainton *sensu* Walsingham, 1907; no reasons are given for this. Walsingham (1907: 268) considered *dubiella* to be a good species.

As far as can be ascertained from surviving specimens, all specimens of '*merdella*' referred to by British authors subsequent to Stainton (1857) and prior to Walsingham (1907) are *flavescetella* Haworth. Stainton's misidentification of certain specimens of *Niditinea fuscipunctella* (Haworth) as *flavescetella* (see Walsingham, 1907) further complicates matters, citations of *flavescetella* including Stainton's records thus being *partim* only. Several authors followed Meyrick (1895) in erroneously considering *flavescetella* to be a synonym of *pellionella*.

It cannot be accepted that the illustration of *Tinea tristigmatella* Costa is suggestive of affinity with *Paratinea merdella* (Zeller) as Zeller (1847: 808) suggested, nor can it be accepted that Stainton (1869: 267) synonymized *tristigmatella* with *pellionella* as stated by Tremewan (1977: 227). Zeller (1847: 808) referred Costa's variety of *tristigmatella* to *pellionella*. In the absence of type-material of *tristigmatella* (Hartig, 1939), the synonymy of Walsingham (1907: 268) – that *tristigmatella* is a junior subjective synonym of *flavescetella* Haworth – should be accepted under the 'first reviser principle' and on the grounds that the illustration by Costa matches *flavescetella* and his description of the biology is compatible with what is known of the biology of *flavescetella*. This synonymy does not stretch credibility on geographic grounds.

All published genitalia figures of males of this species are sadly inadequate and misinterpret the structure of the aedeagus.

Stainton's redescription of '*merdella*' (see above) has been dated 1856 by authors following Walsingham (1907). I can find no published evidence that the *Entomologist's Annual* for 1857 was published in 1856 and I therefore take the date of publication to be that cited on wrappers and title-page – 1857.

BIOLOGY. I have examined specimens carrying accurate label data saying how they were reared (see below) and these refer *flavescetella* to the status of a feather-feeder; Fletcher's specimens may provide evidence that it is also capable of feeding on insect remains and Barrett's record

(1878 : 269) that it may also feed on fur. It has been recorded from inside dwellings and Jacobs' specimens from Smith's Wharf are from inside a warehouse (*pers. comm.*). Distribution records of *flavescentella* suggest that it is restricted to temperate western Europe and the Mediterranean region. It has not, apparently, been collected outdoors in temperate western Europe and may be incapable of a permanent outdoor existence in temperate regions.

Barrett's record of this species breeding in a muff (1878 : 269) can now be confirmed by only a single specimen: muffs were traditionally of fur but could contain other materials. Other published records of the biology of *flavescentella* should be treated with caution as the specimens may well have been misidentified and cannot now be traced and checked: they refer to larvae attacking baize (Pyett, 1902), a woollen pen-wiper (Horton, 1859) and a dead pigeon (Waters, 1928; 1929; Walker & Hobby, 1939). Lafaury (1886 : 410) described the larva of *flavescentella* and pointed out that, in contrast with *pellionella*, it passed the winter without feeding: his identification of *flavescentella* cannot now be verified. Examined specimens in BMNH are reliably labelled as being bred from 'feathers' and 'feathers and dead bluebottles' (Fletcher) and 'feathers' (Jacobs). Dates of collection of adults are February to August inclusive and November: specimens examined include individuals reared under domestic (warm) conditions.

Zagulajev (1960 : 160) gives a detailed account of the biology of *flavescentella* (a species which he states to be unknown to him), stating that it lives in birds' nests, old buildings and bat roosts, that the larvae hibernate, that larvae sometimes develop in houses and infest both coarse and finished felt. The sources he cites for this information are Barrett (1878 - larvae in a house in a muff), Kane (1900 - adults in houses), Bloomfield, Pyett (1902 - larvae on baize) and Corbet & Tams (1943b - larvae on furs and woollen material). Larval hibernation is recorded by Lafaury (see above) but this source is not quoted by Zagulajev. There thus appears to be no factual basis for his suggestions that *flavescentella* is nidicolous and associated with bat roosts. Zagulajev's assertion that *flavescentella* is nidicolous has been quoted without comment by Petersen (1963b : 414) and Hicks (1971 : 178).

DISTRIBUTION. (Fig. 76.) Great Britain, Ireland, Spain, Algeria. The following additional locality records from the literature are here accepted as reliable: Denmark (Pallesen & Palm, 1973), Germany (West and East) (Petersen, 1957; 1969; Hannemann, 1977), Yugoslavia (Petersen, 1962), Rumania (Căpușe, 1968), Italy (Costa, [1836]).

Walsingham's (1907) records of *flavescentella* from France and Spain (the record from Italy is based on *tristigmatella*) cannot be accepted: Walsingham's Spanish specimen has not been found and the record for France (based on Lafaury, 1886) cannot be confirmed. To these records of Walsingham's, Zagulajev (1960 : 159) adds Algeria and Turkey. Both records are erroneous. Zagulajev (1960 : 83) gives Walsingham's paper on *flavescentella* the title of an earlier and entirely unrelated paper on Algerian Microlepidoptera in the same journal and thus may have assumed *flavescentella* to be an Algerian species. His Turkish record refers, of course, to true *Paratinea merdella* (Zeller) from Constantinople, the point of Walsingham's 1907 paper separating *merdella* and *flavescentella* having been missed.

Lhomme (1963 : 1101) records *flavescentella* from four localities in France but these records require verification.

MATERIAL EXAMINED

92 ex. (18 ♂, 20 ♀ genitalia preparations), 0 larvae, 2 cases, 2 pupae. **Great Britain:** 9 ex., Gloucestershire, Stroud, bred from feathers or from feathers and bluebottles, various dates 13.iv.1935 to 9.vii.1936 (Fletcher); 2 ♂, Wiltshire, Marlborough, 26.vi.1890 (Meyrick); 8 ex., Greater London, E.C., Smith's Wharf, ex feathers, various dates 15.ii.1945 to 25.v.1945 (Jacobs); 1 ♂, Greater London, E.C., 30.vi.1934 (Jacobs); 2 ♀, Greater London, Greenwich, no date, ex Sich coll.; 3 ♂, 1 ♀, Dorset, Corfe Castle, various dates 1.viii.1892 to 5.viii.1898 (Bankes); 1 ♀, Dorset, Chick[erell], 25.vii.1891 (Bankes); 3 ♀, Dorset, Weymouth, ii.1895 (Richardson); 1 ♀, Merseyside, Liverpool, no date (Pierce) (paralectotype of *metonella* Pierce & Metcalfe); 4 ex., no data, ex Meyrick coll.; 2 ♀, no data, ex Vine coll.; 1 ex., no data, ex Hodgkinson coll.; 14 ex., no data, ex Walsingham coll.; 6 ex., no data, ex Douglas coll.; 4 ex., no data, ex Stevens coll.; 19 ex., no data [? Staffordshire - see Hulme, 1972], ex Mason coll.; 2 ex., no data, ex Tyerman coll.; 1 ♀, no data, 30.viii.1884 (Tutt); 4 ex., no data, 9.xi.1883 (Sang); 1 ♀, no data, 1877 (Barrett).

Ireland: 1 ♂, Co. Clare, Burren, 3–8.vi.1951 (*Bradley*); 1 ♂, Co. Cork, Bantry, 4–15.vi.1952 (*Bradley*).
 Spain: 1 ♂, Prov. Avila, Sierra de Gredos, Garganta de las Pozas, 1800 m, 12.vii.1970 (*Sattler & Kirby*).
 Algeria: 1 ♂, Prov. Oran, Sidi-bel-Abbés, 2.ix.1917 (*Rotran*).

Tinea roesleri Gozmány
 (Figs 1, 27, 40, 57, 65, 76, 84)

Tinea roesleri Gozmány, 1969, *Ent. Z., Frankf. a. M.* 79: 69, figs 1, 2. Holotype ♂, SOUTH WEST AFRICA: Mariental, Galtsabis Farm, bred from owl pellets, 9.iv.1965 (*Schwind*) (genitalia slide no. 2244 [Petersen]; MAK, Bonn) [not examined].

Tinea roesleri Gozmány; Gozmány & Vári, 1973: 50, figs 107, 108 [redescription].

♂. 9–10 mm. Head light greyish cream. Maxillary palpus whitish. Labial palpus whitish, terminal segment with light brownish scales on outer surface at one-half. [Head preparation not made owing to lack of material]. Galea apparently short as in *flavescentella*. Antenna brownish white, almost reaching apex of fore wing. Thorax and tegula greyish cream, tegula speckled anteriorly with a few light brown scales. Fore wing dull greyish cream speckled all over with light brownish grey scales; fringes light brownish grey. Discocellular spot present, small, ill-defined, greyish brown; discal and plical spots absent. Hind wing greyish white speckled with light brownish grey scales, fringes pale brownish grey. Legs whitish, fore leg greyish brown above. Abdomen greyish brown.

♀ (Fig. 84). 14 mm. Coloration as ♂.

GENITALIA ♂. [One genitalia slide examined.] Saccus very short, 0.55 mm long. Costa of valva concave to three-quarters, rounded to apex without noticeable truncation. Dorsal margin of gnathos angled at one-third, otherwise straight, tip curved inwards towards tip of uncus. Anellus spines (Fig. 40) short and broad, arranged in fairly narrow band with about 16 spines prominent. Aedeagus (Fig. 27) short, 1.03 mm long; tip with seven prominent carinae; vesica with pair of distorted blade-shaped cornuti. Aedeagus/saccus ratio 1.86.

GENITALIA ♀. [One genitalia slide examined.] Eighth sternite with deep and narrow U-shaped emargination. Antrum (Fig. 65) elongate, swollen posterior region narrow; transverse folds present but ill-defined; longitudinal folds conspicuous, not divided transversely. Corpus bursae (Fig. 57) with six minute, thorn-like signa arising from very small, circular sclerotized base-plates.

REMARKS. *Tinea roesleri* is a darker and more dull-coloured species than *flavescentella* and, under low magnification, has a distinctly speckled appearance. The configuration of carinae at the tip of the aedeagus is similar to that of *flavescentella* but *roesleri* possesses large blade-shaped cornuti similar to those of most other members of the *pellionella*-group. These are, however, distinctly contorted to a shape not observed in other members of the *pellionella*-group. The female genitalia of *roesleri* resemble those of *murariella* and *translucens* but in *roesleri* the longitudinal folds of the antrum are not transversely divided; the signa of *roesleri* are smaller and more numerous than those of *translucens* or *murariella*.

In his descriptions of this species, Gozmány (1969: 69; Gozmány & Vári, 1973: 50) claims that the female has two large signa 'resembling those of *pellionella*'. His figure shows four very small signa. In the case of the male he interprets the carinae as cornuti. He states that the aedeagus is as broad as the valva (Gozmány & Vári, 1973: 50) but in the specimen examined, the aedeagus is less than two-thirds the width of the valva and even if compressed flat beneath the coverslip would not be as wide.

This species is known only from the type-series which consists either of holotype and 74 paratypes (Gozmány, 1969: 71) or holotype and 70 paratypes (Gozmány & Vári, 1973: 50).

BIOLOGY. *Tinea roesleri* is known only from Mariental, near the edge of the Namib Desert: larvae were found feeding in owl pellets which would probably have contained fur and insect remains. Exact details of the type-locality are not available but there is enormous diurnal variation in both temperature and humidity in this area. This species may be adapted to scrub desert conditions or it may have been breeding in less extreme conditions in farm buildings. Adults emerged in April.

DISTRIBUTION. (Fig. 76.) South West Africa.

MATERIAL EXAMINED

3 ex. (1 ♂, 1 ♀ genitalia preparation), 0 larvae, 3 cases, 0 pupae. South West Africa: 2 ♂, 1 ♀, Mariental, Galtsabis Farm, bred from owl pellets, 9.iv.1965 (*Schwind*) (genitalia slide nos G-01, 1328; TM, Budapest and BMNH, London) (paratypes).

Tinea pellionella Linnaeus

(Figs 1, 2, 4, 14–16, 28, 29, 43, 50, 58, 77, 85, 86)

- Phalaena (Tinea) pellionella* Linnaeus, 1758, *Syst. Nat.* (edn 10) 1: 536. Neotype ♂, [BRITAIN]: abdomen and genitalia (the extreme right specimen with gnathos and uncus in dorsoventral view) on F. N. Pierce Slide No. 3222 (BMNH, London) designated by Rasmussen (1964: 336, pl. 2, fig. 5) [examined].
- Phalaena zoolegella* Scopoli, 1763, *Ent. carniolica*: 255. Type[s], [YUGOSLAVIA] (assumed to be destroyed – see Horn & Kahle, 1936: 252). [Synonymized by Zeller, 1839: 184.]
- Tinea albella* O. G. Costa, [1836], *Fauna Regno Napoli*, Lepidotteri: [231], [234], [312], pl. (Lep. Nott.) 4, fig. 9A (nom. praeocc.). Types, ITALY: Naples [not found; not examined]. [Synonymized by Stainton, 1869: 267.]
- Tinea demiurga* Meyrick, 1920, *Exot. Microlepidopt.* 2: 354. LECTOTYPE ♂, INDIA: Assam, Shillong, vi.1920 (*Fletcher*) (genitalia slide no. 13301; BMNH), here designated [examined]. *Syn. n.*
- Tinea gerasimovi* Zagulajev, 1978, *Ent. Obozr.* 57: 622, figs 10, 11. Holotype ♂, U.S.S.R.: Central Asia [?] (*Gerasimov*) (genitalia prep. no. 8627; ZI, Leningrad) [examined]. *Syn. n.*
- [*Tinea pellionella* L.]; Cuba, 1491: 1 Animalibus cxlv, woodcut [description; herbal remedies; woodcut of woman brushing moth-damaged garments]; Anonymous, 1521: 73 [damage; control; woodcut from Cuba, 1491; see quotation in 'Introduction']; Moffett, 1634: 97 [description; figure]; Réaumur, 1737: 41, pls 5, 6 (excluding pl. 6, figs 9, 10) [damage; biology; case-building and larval behaviour; control]; Rösel von Rosenhof, 1746: 46, pl. 17, figs 1–6 [description; biology; excellent colour figs of life history]; Anonymous, 1759: 365 [biology; control]; Kalm, 1771: 8 [first North American record]; Ebert, 1778: 95 [description; damage].
- Tinea pellionella* L.; Linnaeus, 1761: 364 [description]; Poda, 1761: 94, pl. 2, fig. 12 [adult and case figured]; Müller, 1764: 57 [description]; Fabricius, 1775: 659; Fuessli, 1775: 42 [Switzerland]; Müller, 1776: 134 [description]; Mader, 1777: 119 [dates of appearance]; Fischer, 1778: 155 [Livonia]; Leske, 1779: 464 [description]; Fabricius, 1781: 295; Goeze, 1783: 92 [bibliography]; Strøm, 1786: 340 [Norway]; Fabricius, 1787: 246; de Villers, 1789: 466 [bibliography]; Rossi, 1790: 205; Fabricius, 1794: 304; Hübner, 1796: 61, pl. 3, fig. 15; Fabricius, 1798: 490; Cederhielm, 1798: 256 [description; bibliography]; Geoffroy, 1800: 184 [description; damage – see also p. 173]; Stewart, 1802: 198; de Tigny, 1802: 92, pl. facing 94, figs 3–6 [description; figures]; Walckenaer, 1802: 318 [as '*pelionella* F.']; Schrank, 1802: 106 [description]; Haworth, 1802: 37; Latreille, 1805: 249 [description]; Kirby & Spence, 1818: 233 [damage]; Samouelle, 1819: 249, 370 [description; dates of appearance; as '*Physis pelionella*']; Schmid, 1822: 129, pl. 19, fig. 4 [description; figure]; Hübner, 1825: 401; Hübner, 1826: 70; Haworth, 1828: 563; Stark, 1828: 369; Stephens, 1829a: 51; Stephens, 1829b: 224; Curtis, 1831: 187; Rennie, 1832: 222 [description; biology]; Kollar, 1832: 87 [Austria]; Treitschke, 1832: (1)15 [life history; description of case and larva]; Eversmann, 1834: 21 [central U.S.S.R.]; Stephens, 1834: 345 [description]; Costa, [1836]: [214] [description; Italy]; Kollar, 1837: 392 [description; damage]; Curtis, 1837: 215; Duponchel, 1838: 92, pl. 289, fig. 1 [biology; description]; Zeller, 1838: 708 [description; differentiation of *bisselliella*]; Wood, 1839: 224, pl. 49, fig. 1555 [description; figure of adult]; Zeller, 1839: 184; Döring *et alii*, 1840–46: (1)6, (2)12, (3)16; (4)16, (5)16, (7)16; Zetterstedt, 1840: 992 [description; Scania, Lapponia]; Harris, 1841: 360; Eversmann, 1844: 534 [larva and case; damage; Volga – Urals region of U.S.S.R.]; Treitschke, 1844: 390; Humphreys & Westwood, 1845: 246, pl. 118, fig. 10; von Tiedemann, 1845: 543 [Prussia]; Duponchel, 1846: 364; Lienig & Zeller, 1846: 272 [parasites; description of larva and adult]; Kolenati, 1846: 109 [Transcaucasia]; Koch, 1848: 950 [Germany]; Stainton, 1849a: 8; Stainton, 1849b: 2630; Stainton, 1851: 17 [Vienna]; Heydenreich, 1851: 79; Zeller, 1852: 157 [description; variation; bibliography]; Stainton, 1852: 11 *et seq.* [dates of generations]; Ghiliani, 1852: 79 [Italy]; Herrich-Schäffer, 1853: 72, fig. 278; Stainton, 1854a: 33; Stainton, 1854b: 14 [bibliography]; Koch, 1856: 378; Frey, 1856: 25 [Switzerland]; Freyer, 1856: 59, pl. 11, fig. 27 [description; damage]; de Fré, 1858: 112 [dates of appearance of adult; larval damage; Belgium]; Praun, 1858–1870: Tineacea, pl. 1, fig. 18 and facing p. [figure; description]; Stainton, 1859b: 292 [description; localities in Britain]; Doubleday, 1859: 27; Nowicki, 1860: 168; Wocke, 1861: 107; Walker, 1863: 468 [Britain; Europe; *partim* – not Ceylon]; Werneburg, 1864: (1)18, 37, 165, 232, 298, 312, 469, 479, (2)253 [bibliography]; Rössler, 1866: 316; Constant, 1866: 308 [French vernacular names; foodstuffs] Stainton, 1867b: 265 [description; biology]; Speyer,

1868 : 255, pl. 34, fig. 9 [description; figure]; Cornelius, 1869 : 410 [birds' nests]; Stainton, 1869 : 56, 116, 126, 266, 284, 307, 322 [S. Europe]; Heinemann, 1870 : 54; Morris, 1870 : 22, pl. 99, fig. 7; de Graaf, 1870 : 146, pl. 34, figs 1–12 [biology; excellent colour plate of life-history]; Wocke, 1871 : 270; Peyerimhoff, 1872 : 142 [Alsace]; Haas, 1874–5 : 5 [biology; Denmark]; Hofmann, 1875 : 70 [biology]; Merrin, 1875 : pp. [annual cycle]; Millière, (1876) : 308; Chambers, 1878 : 164; Hartmann, 1879 : 199; Seebold, 1879 : 125 [Spain]; Frey, 1880 : 337 [Switzerland]; Fettig, 1882 : 88 [variation; damage; Alsace]; Cholodkowsky, 1882 : 262 [notes on anatomy]; Snellen, 1882 : 468 [Netherlands]; Walsingham, 1882 : 170 [North American records and literature; synonymy]; Fernald, 1882 : 166 [North American nomenclature of clothes-moths – see Walsingham, 1882]; Porritt, 1883 : 134 [Britain – Yorkshire]; Curò & Turati, 1883 : 8 [Italy]; Fernald, 1884 : 439, fig. 558; Farren, 1886 : 78 [Britain – Cambridgeshire]; Sorhagen, 1886 : 148 [generations; Berlin area]; Lafaury, 1886 : 411 [biology]; Edwards, 1889 : 120 [bibliography of life-history data]; Riley, 1890 : 212 [figures of larva, case and adult]; Oudemans, 1890 : xxx [biology]; Riley, 1890–1 : 15, 461 [parasites]; Riley, 1891 : 96; Fletcher, 1893 : 54, figs 32–34 [biology; damage]; Griffini, 1895 : 231, fig. 148; Comstock & Comstock, 1895 : 257 [biology; control]; Meyrick, 1895 : 791 [Britain; *partim* – not *dubiella* Stainton or *flavescentella* Haworth]; Butler, 1896 : 92; Marlatt, 1896 : 63, fig. 25 [biology; control]; Reutti, 1898 : 303 [Europe]; Seebold, 1898 : 162 [Spain]; Kane, 1900 : 127 [Ireland]; Rebel, 1901 : 238; Strand, 1901 : 38 [Norway]; Schütze, 1902 : 3 [Germany (East)]; Dyar, [1903] : 572; Rebel, 1904 : 373 [Balkans]; Dietz, 1905 : 51 [description; distinct from *griseella* and *carnariella*; U.S.A.]; Jussel, 1905 : 21 [birds' nests]; Crombrugghe de Picquendaele, 1906 : 124 [dates of larvae and adults; bibliography; Belgium]; Walsingham, 1907 : 267 [biology; bibliography]; Poole, 1909 : 432 [Britain – I. of Wight]; Meess, 1910 : 461 [distribution]; Gianelli, 1911 : 119 [damage; Italy]; Hauder, 1912 : 284; Herrick, 1914 : 189, figs 52, 53 [biology; control; good figures of case and adult]; Marlatt, 1915 : 1 [biology; damage; control]; Ossipov, 1915 : 897 [repelled by *Melilotus officinalis*]; Andres, 1916 : 51 [Malta]; Andres, 1918 : 366 [control with HCN gas]; Titschack, 1922 : 1 [comparisons with *bisselliella*; egg – fig. 62]; Wolff & Krausse, 1922 : 41 [pest status]; d'Abadie, 1922 : 212 [in swallows' nests]; Back, 1923 : 1 [control – see Back, 1935]; Rebel, 1927 : 63 [Cyprus]; Waters, 1928 : 176, 177 [Britain – Oxford district – in houses and birds' nests]; Forbes, 1928 : 538 [U.S.A. – New York]; Metcalf & Flint, 1928 : 748, fig. 504 [biology; damage, control]; Ford, 1929 : 261 [birds' nests]; Waters, 1929 : 58 [sparrows' nest, Oxford]; Bruneteau, 1930 : 149 [biology; control; parasites; bibliography]; Back & Cotton, 1930 : 835 [damage; useful period bibliography on control and of popular accounts]; Morley, 1930 : 101 [parasite]; Voukassovitch & Voukassovitch, 1931 : 695 [parasite]; Ford, 1931 : 259 [common in stables]; Back & Cotton, 1931 : 1 [damage to upholstered furniture; biology; control]; Schütze, 1931 : 211 [biology]; Burgess & Poole, 1931 : 141 [damage]; Morley & Rait-Smith, 1933 : 174 [parasites]; Eckstein, 1933 : 187, pl. 7, fig. 315 [description of larva and adult]; Britten, 1935 : 18 [in swallows' nests]; Donisthorpe, 1935 : 70 [in herons' nest]; Back, 1935 : 1 [biology; control]; Pierce & Metcalfe, 1935 : 94, pl. 58 [♂, ♀ genitalia]; Nordberg, 1936 : pp. [in birds' nests]; Herfs, 1936 : 1, 5 [in sparrows' nests]; Britten, 1936 : 110 [in swallows' nests]; Skala, 1936 : 172 [Czechoslovakia]; Rapp, 1936 : 219 [Thuringia]; Thompson, 1937 : 88 [from puffins' burrows, Ireland – N. Antrim]; Eichler, 1937 : 61 [birds' nests]; Pappenheim, 1938 : 240 [structure of eggs]; Uhlmann, 1938 : 8 [birds' nests; pest status]; Kemper, 1938a : 227 [birds' nests]; Kemper, 1938b : 272 [birds' nests]; Hudson, 1939 : 467, pl. 61, fig. 22 [larva; damage; description; New Zealand]; McDunnough, 1939 : 105 [U.S.A.]; Hartnack, 1939 : 186 [damage; identification; humidity requirement over 75% R.H.]; Herter, 1939 : 746 [birds' nests]; Walker & Hobby, 1939 : 105 [Britain – Oxfordshire]; Jellison, 1940 : pp. [birds' nests]; Ferrière, 1941 : 374 [parasites]; Burks, 1943 : 566 [hyperparasitism]; Corbet & Tams, 1943a : 113 [type-species of *Tinaea* Geoffroy – see also ICZN, 1957]; Corbet & Tams, 1943b : 111, 143, figs 199, 229, 256, 284, pl. 5, figs 29, 30 [identification; distribution; biology]; Hinton, 1943 : 211, fig. 127 [larva]; Doner & Thomssen, 1943 : 102 [biology; control, economic bibliography]; Jenkins, 1944 : 52 [biology; control]; Linsley, 1946 : 12 [birds' nests as infestation sources]; Thompson, 1947 : 580 [parasites]; Mason, 1948 : 28 [parasite]; Richards, 1949 : 29, 32 [parasites]; Ford, 1949 : 184 [biology]; Woodroffe & Southgate, 1950 : 30 [birds' nests]; Southgate & Woodroffe, 1951 : 44 [birds' nests]; Woodroffe & Southgate, 1951a : 171 [parasite]; Woodroffe & Southgate, 1951b : 55 [birds' nests]; Pest Infestation Research Board, 1951 : 5 [birds' nests]; Rothschild & Clay, 1952 : 250 [birds' nests]; Weidner, 1952 : 119, 134 [birds' nests]; Agenjo, 1952 : 61 [Spain]; Woodroffe, 1953 : 743, 745 [birds' nests]; Herter, 1953 : pp. [development temperatures]; Hudson, 1954 : 73 [facsimile of Anonymous, 1521 and woodcut]; Prevtz, 1954 : 3 [on dead pheasant]; Hinton, 1956 : 303, figs 147–160 [description of larva; bibliography]; Viette, 1957 : 116 [birds' nests]; Petersen, 1957 : 145, figs 109, 110 [genitalia]; ICZN, 1957 : 254 [placed on Official List of Specific Names in Zoology; type-species of *Tinea*]; Werner, 1958 : 97, figs 142–144 [larval description]; Zagulajev, 1958 : 42 [biology; control]; Hicks, 1959 : 275 [bibliography of birds' nest records];

- Petersen, 1959b : 156 [Germany; *partim* – 2 ♀ are *dubiella*]; Key & Common, 1959 : 29 [ecology in a bulk wool store, Australia]; Petersen, 1960 : 226 [Spain]; Zagulajev, 1960 : 149, figs [identification; biology; distribution; U.S.S.R.]; Razowski & Śliwiński, 1961 : 42 [Poland; domestic pest; as *Tineola pellionella*]; Woodroffe, 1961 : 281 [birds' nests]; Petersen, 1961b : 58 [Germany]; Hicks, 1962 : 267 [bibliography of birds' nest records]; Lhomme, 1963 : 1100 [France; Belgium]; Petersen, 1963b : 414 [birds' nests]; Petersen, 1963c : 12 [Albanian records rejected]; Hartig, 1964 : 225 [Italy – Venice region]; Petersen, 1964b : 77 [status as 'domestic' species]; Petersen, 1964c : 121 [Germany]; Petersen, 1964d : 404, 417 [Spain]; Rasmussen, 1964 : 336, pls 1–4, figs 1–16 [♂, ♀ genitalia; neotype designated]; Mitchell & Zim, 1964 : 153, col. fig. [popular account; figure of adult]; Opheim, 1965 : 57 [Norway]; Anonymus, 1965 : 1 [moth-proofing and control; bibliography on moth-proofing techniques]; Gozmány & Szócs, 1965 : 142, figs 36A, 37A, 38A, 38B [key; Hungary; genitalia figures]; Gradidge *et alii*, 1967 : 8, fig. 6 [biology; damage; control]; Căpușe, 1968 : 319, figs 11E, 13A, 19A, 165, 166, 169A [Rumania; figures mostly from Zagulajev, Hinton and Petersen – original figures wholly inaccurate]; Klimesch, 1968 : 182 [Macedonia]; Petersen, 1968 : 98 [Germany (West)]; Chauvin, 1968a : 40 [activity]; Chauvin, 1968b : 49 [adult activity]; Chauvin, 1968c : 431 [case-building]; Chauvin, 1968d : 2229 [larval activity as function of egg weight]; Chauvin, 1969a : 2673 [ovaries]; Chauvin, 1969b : 23 [adult and larval activity]; Chauvin, 1969c : 89 [case-building activity]; Petersen, 1969 : 373, pl. fig. 24, figs 150, 159, 167 [♂, ♀ genitalia; biology; distribution; Germany (East) – all regions except Schwerin, Suhl and Leipzig]; Chauvin, 1970 : 9 [case-building activity]; Chauvin, 1971a : 1111 [humidity and survival]; Chauvin, 1971b : 509 [fecundity]; Chauvin, 1971c : 350 [activity rhythms]; Krogerus *et alii*, 1971 : 28 [Scandinavia]; Hicks, 1971 : 178 [bibliography of birds' nest records]; Zagulajev, 1972 : 684 [Mongolia]; Bradley *et alii*, 1972 : 8; Barbier & Chauvin, 1972 : 1003 [studies on ova]; Bollobás & Vojnits, 1972 : 467 [damage to human anatomical preparations]; Opheim, 1973 : 44, fig. 7 [Norway; records from birds' nests]; Ebeling, 1975 : 314, fig. 203 [biology; figure of case]; Nixon, 1976 : 706 [parasite]; Hannemann, 1977 : 217, pl. 14, fig. 9, figs 118a–c, A33, A34 [larva; genitalia; biology; Germany (East)]; Chauvin, 1977 : 1 [detailed and important study of humidity tolerance and adaptation to dry environments]; Mourier & Winding, 1977 : 96, pl. 6 [coloured figs of larva, case and adult].
- Tinea zoolegella* Scopoli; Goeze, 1783 : 92, 149 [catalogue]; Zeller, 1839 : 184 [as variety of *pellionella*]; Duponchel, 1846 : 364 [as variety of *pellionella*]; Herrich-Schäffer, 1853 : 72 [synonym of *pellionella*]; Zeller, 1855 : 256 [synonym of *pellionella*]; Frey, 1856 : 25 [synonym of *pellionella*]; Werneburg, 1864 : (1)233 [synonym of *pellionella*]; Stainton, 1869 : 307 [synonym of *pellionella*].
- Tinea albella* O. G. Costa; Curò & Turati, 1883 : 10 [not known to authors]; Stainton, 1869 : 267 [? junior subjective synonym of *pellionella*]; Tremewan, 1977 : 220 [current status; junior primary homonym of *albella* Thunberg].
- [*Tinea flavifrontella* Hübner; Packard, 1867 : 423 (*partim* – larva only) [description; biology]; Packard, 1873 : 64, figs 57–60 (*partim* – larva only); Williams, 1874 : 27; Walsingham, 1882 : 170 [misidentification of *pellionella* attributed to Packard]; Fernald, 1882 : 169 [misidentification of *pellionella* attributed to Packard]; Packard, 1888 : 346; Denton, 1900 : 45, fig. [popular account]. Misidentifications.]
- [*Tinea griseella* Chambers; Fernald, 1882 : 169 [synonym of *pellionella*]; Walsingham, 1882 : 170 [synonym of *pellionella*]; Riley, 1891 : 96 [synonym of *pellionella*]; Dyar, [1903] : 572 [synonym of *pellionella*]. Misidentifications.]
- [*Tinea carnariella* Clemens; Walsingham, 1882 : 170 [synonym of *pellionella*]; Fernald, 1882 : 169 [synonym of *pellionella*]. Misidentifications.]
- [*Tinea merdella* Zeller; Dyar, [1903] : 572 [synonym of *pellionella*]; Crombrugghe de Picquendaele, 1906 : 124 [synonym of *pellionella*]. Misidentifications.]
- [*Tinea murariella* Staudinger; Căpușe, 1968 : 334, figs 175A, 175B (*partim* – ♂ only). Misidentification.]
- ♂ (Fig. 85). 9–13 mm. Head rich brown with slightly reddish tint. Maxillary palpus brownish grey, almost reaching tip of third segment of labial palpus. Labial palpus greyish brown, outer surface of terminal segment darker. Galea extending almost to one-half of second segment of labial palpus. Antenna greyish brown, almost reaching apex of fore wing. Thorax and tegula greyish brown. Fore wing greyish brown, closely speckled with darker scales to give an overall dark, dull brown coloration; basal scales posterior to fold and scales forming discocellular, discal and plical spots dark brown and closely-packed. Hind wing very light grey with a slight brownish tint, scales somewhat darker towards margins, fringes concolorous. Legs light greyish brown, fore legs slightly darker above. Abdomen light greyish brown.
- ♀ (Fig. 86). 11–16 mm. Coloration as ♂.
- GENITALIA ♂. Saccus elongate, 0.84 ± 0.18 mm long. Valva (Fig. 43) of rather variable shape, costally gently concave, apex not noticeably truncated at costal margin. Dorsal margin of gnathos straight, tip

upturned towards uncus. Anellus spines (Figs 28, 29) of medium size, only slightly protuberant [Fig. 28 is of an atypical specimen], in a short row usually three spines wide and comprising 15–20 heavily sclerotized spines. Aedeagus (Figs 14–16) 1.22 ± 0.20 mm long, curved; patch of five to ten minute, thorn-like carinae at either side below apex; vesica with pair of large, evenly-tapered, blade-shaped cornuti – these visible in dorsoventral view (Fig. 15) only if aedeagus viewed with curve towards observer and more usually seen in lateral view (Figs 14, 16) in which their twisted shape is more apparent. Aedeagus/saccus ratio 1.47 ± 0.25 .

GENITALIA ♀. Eighth sternite with broad V-shaped emargination (Figs 50, 58) with small, lateral sclerotized patches at base of emargination. Antrum (Fig. 58) short, broadened posteriorly into an almost spherical chamber in which transverse folds are weakly developed and weakly sclerotized; longitudinal folds short, conspicuous, transversely divided in posterior half. Corpus bursae (Fig. 50) with two to five conspicuous, needle-like signa, each arising from one side of a short, broad, blade-shaped eccentric base which may be doubly-peaked, 'needle' arising from base of smaller peak; each 'needle and base' set in dished, circular, sclerotized base-plate which is evenly sclerotized and has regular margin.

REMARKS. *Tinea pellionella* is a dark species with well-defined fore wing spots. The hind wing is pale in comparison with *dubiella*; *pellionella* is generally the larger species. The male genitalia are remarkable in that the vesical ornamentation consists of two plain, blade-shaped cornuti and the carinae on the aedeagus are very small and thorn-like. Carinae of this type are found in no other member of the *pellionella*-group although they resemble superficially the carinae of *hongorella* (q.v.). The short and bulbous female antrum is characteristic. (See also 'Remarks' for *translucens*.)

The literature on this species is diverse and covers a long period of human history (see above). The majority of the references to *pellionella* cannot now be verified because substantive specimens are no longer available or were never retained. Where I can find no evidence to doubt a record of *pellionella* I have included it in the list of citations (above). I consider a number of the traditionally-cited references to this species to involve misidentifications; *pellionella* is not known from the localities to which these references apply and, moreover, may be known to be replaced by other species of the *pellionella*-group. Biblical sources are unlikely to refer to *pellionella*: the species mentioned might have been *murariella*, *translucens* or *messalina*. Stainton's records from Syria and Asia Minor (1867a : 4, 10, 27) are similarly suspect and might also refer to one of these three species. Records from humid tropical regions, notably lowland India and Sri Lanka (Ceylon) (Walker, 1863 : 468, *partim*; Moore, 1887 : 500; Swinhoe & Cotes, 1889 : 703; Fletcher, 1921 : 190) are here considered to be referable to *translucens* as is the major biological study by Cheema (1956 : 167). *Tinea pellionella* is not known from the Neotropical region: Zeller's specimen from Colombia (1877 : 214) is not a member of the *pellionella*-group and the *Tinea* mentioned by Brèthes (1920) is here considered to be *murariella*. All specimens recorded from the Canary Islands and Madeira as *pellionella* by Rebel and Walsingham have been found, on examination, to be *dubiella*: only two records remain unverified (Rebel, 1892 : 269; Walsingham, 1894 : 541) and these probably also refer to *dubiella*. Specimens of '*pellionella*' recorded from Ireland by Bradley (1952) are *flavescentella*. Rebel's record of *pellionella* from Socotra (1907) must be referable to one of the arid-zone species, *murariella* or *messalina*. Zeller's record (1847 : 810) of *pellionella* from Sicily is erroneous: the specimen collected on 4 May is not a member of the *pellionella*-group and the second specimen, collected on 8 May, cannot now be found. Records involving bizarre pabula (Walsh, 1929 : 151; Fletcher, 1933 : 78; Hinton & Greenslade, 1943 : 182) must be considered doubtful in the absence of substantive specimens. I have been unable to confirm the presence of *pellionella* in Japan where *translucens* has been found to be widespread. In the absence of further evidence, I consider all Japanese records of '*pellionella*' to be misidentifications of *translucens*: the records are those of Nagamori (1925), Matsumura (1931), Watanabe (1932), Yamada (1940), Esaki *et alii* (1953), Issiki (1957) and Okano (1959). Silvestri's (1943 : 102) entry for *pellionella* appears, from his figure of the female genitalia, to be referable to *murariella*.

A number of species have, at various times, been erroneously placed in synonymy with *pellionella*, notably *Paratinea merdella* (Zeller) (Dyar, [1903]), *Tinea griseella* Chambers and *Tinea carnariella* Clemens (Walsingham, 1882, and by Fernald, 1882), *Tinea dubiella* Stainton (Stainton, 1874), *Tinea lanella* Pierce & Metcalfe (Agenjo, 1952) and *Tinea tristigmatella* Costa (Tremewan,

1977). *Tinea turicensis* Müller-Rutz was erroneously synonymized with *pellionella* by Müller-Rutz himself (1932 : 263), a synonymy apparently overlooked by subsequent authors while the erroneous synonymy of *dubiella* has been accepted without question up to the present time even though A. S. Corbet dissected a syntype of *dubiella* some time before 1943. Other synonymies have been either overlooked, as in the cases of *zoolegella* Scopoli and *albella* O. G. Costa, or, in the case of *demiurga* Meyrick, never made.

Tinea albella O. G. Costa is a junior primary homonym of *Tinea albella* Thunberg, 1788 (Tremewan, 1977 : 220). In the absence of type-material of *albella* (Hartig, 1939), the synonymy of Stainton (1869 : 267) – that *albella* is probably (Stainton used a '?') a synonym of *pellionella* – should be accepted under the 'first reviser principle'.

This is the '*Tinea flavifrontella*' of certain North American authors who compounded the original misidentification of *Tineola bisselliella* by Packard (1867), an error which persisted despite the efforts of Fernald (1882) and Walsingham (1882) until its last commission by Denton in 1900. The name '*flavifrontella*' probably covered a multitude of sins but *bisselliella* appears to have been the main species involved.

There is a paucity of good illustrations of *pellionella* and its early stages. The best illustrations are those of Réaumur (1737), Rösel von Rosenhof (1746) and de Graaf (1870). American literature contains, in the main, reprinted or copied versions of the illustrations first used by Riley in 1890. The genitalia figures of this species given by Petersen (1957; 1969), Rasmussen (1964) and Hanemann (1977) are helpful and accurate: those given by Căpușe (1968) are not.

BIOLOGY. This species is capable of utilizing a wide variety of foodstuffs containing keratin in various forms and is, with *Tineola bisselliella*, the agent traditionally responsible for 'moth-damage' to woollen materials in temperate regions. In non-domestic situations, *pellionella* is found feeding on feathers and wool in the nests of a wide variety of birds (see Hicks, 1959; 1962; 1971) and has been bred from owl pellets (Bowles, *pers. comm.* – specimen in BMNH). It will feed on the feathers or fur of animal corpses (Prevett, 1954). It has also been bred from fish-meal in Canada (Morris – specimens in BMNH) and may well be able to utilize insect remains (Scopoli, 1763) as can *murariella*. In domestic environments, attacks on woollen material tend to be concentrated on soiled or unwashed wool (Key & Common, 1959); feathers in pillows are eaten and the woollen or horse-hair stuffing or padding of upholstery may be attacked (Back & Cotton, 1931). I recently received larvae of *pellionella* feeding on a carpet composed of 20% wool and 80% synthetic fibre: all fibres had been indiscriminately cut close to the base of the carpet and the wool fibres eaten.

Tinea pellionella is restricted to temperate and cool Mediterranean zones in the Palaearctic and Nearctic regions and is present in Australia and New Zealand. In warmer regions or environments it is replaced as a pest by *translucens*, *murariella* or *dubiella*. It is found in warehouses, stores and outbuildings but is now, in Britain at least, rare in houses and apparently restricted to those which are damp, poorly heated or unoccupied.

Details of the life-cycle of *pellionella* are not well known. Thorough studies are few and some (e.g. Cheema, 1956) do not deal with *pellionella* as claimed. The egg (figured by Titschack, 1922, Pappenheim, 1938 and Chauvin, 1977) takes six to eight days to hatch (Zagulajev, 1960). Case-building activity begins immediately after hatching. The case is made predominantly from silk, with particles of the food substrate and frass attached or adhering. A description of case-building activity is given by Réaumur (1737) whose detailed observations have not been significantly added to or bettered by subsequent authors (see, for example, Butler, 1896). A modern approach to the detailed study of the life-history of this species has been taken by Chauvin in a series of papers (1968–1977). The period of the first instar is seven to ten days (Zagulajev, 1960) and the normal number of larval instars varies from six to eight (Zagulajev, 1960) or six to ten (Chauvin, 1977). The optimal temperature for larval development is 23–25 °C according to Zagulajev (1960); Chauvin (1977) reared his cultures at a temperature fluctuating between 15 and 25 °C and thought 20 °C to be about the optimal temperature. At 25 °C he found that *pellionella* was continuous-brooded with a generation time of about three months, giving a total larval period of about ten weeks and a pupal period of about two weeks. Under natural conditions the generation

time is, of course, longer: Chauvin (1977) found *pellionella* to be univoltine in western France but Zagulajev (1960) reported bivoltinism in *pellionella* in the southern U.S.S.R. and univoltinism in the north. Presumably, in the milder conditions of outbuildings or houses two or more generations can occur each year in north temperate regions. The larva of *pellionella* has been described in detail by Hinton (1956). When fully grown, larvae leave the food source and climb upwards and attach their cases to hang from a horizontal surface such as a ceiling (Zagulajev, 1960). Pupation occurs within the case, the pupal period occupying 10–15 days. In a univoltine population, larvae occupy the pupation site in the autumn and pupation does not occur until spring (Zagulajev, 1960). However, according to Lafaury (1886) larvae continue to feed all winter; Ford (1949) records that *pellionella* overwinters as a larva. Shortly before emergence, movements of the pupa occur which, in conjunction with the backward-pointed spines of the pupal abdomen, protrude the head and thorax of the pupa from the larval case; the adult then emerges. Mating occurs on the day of emergence or the next day, usually in the evening (Zagulajev, 1960). Oviposition and oviposition behaviour are described by Zagulajev (1960) and Chauvin (several papers) and fecundity has been studied by Chauvin (1971*b*) and Zagulajev (1960). The period of adult survival is largely dependent upon temperature and humidity and whether or not individuals have mated – Titschack (1922), working with *Tineola*, found that heavy virgin females lived longest, lightweight mated females the shortest.

Apart from the notable exception of Chauvin's studies, little experimental work has been carried out on correctly identified cultures of *pellionella* and some enigmas remain, notably with respect to the tolerance of this species to humidity and temperature. The broad relative humidity tolerance (0–100%) recorded by Chauvin is at odds with the observations of Hartnack (1939) who found that *pellionella* would not develop successfully at a relative humidity of less than 75%. Hartnack's observations accord with mine – I have been unable to keep young larvae of *pellionella* alive at a temperature of 20–25 °C and a relative humidity of 45–55%. Furthermore, *pellionella* is apparently not found in dry, modern centrally-heated houses (in which the humidity is low). Conflict is also to be found in accounts of how *pellionella* overwinters: the reports of Lafaury, Ford and Zagulajev (above) are at variance and may be explicable by regional (climatic) variation.

There is a large amount of literature on the biology of *pellionella* with special reference to economic aspects. Virtually all of these are by authors unaware of the multiplicity of species masquerading as '*pellionella*'. Among the many works listed above, those of Edwards (1889), Herrick (1914) and the several papers by Marlatt, Back and Cotton are particularly useful as is the more modern work by Gradidge *et alii* (1967). An excellent review of modern moth-proofing techniques is given in the *Wool Science Review* (Anonymous, 1965); this paper has also a very good bibliography.

Reports of domestic outbreaks of *pellionella* now seem to be rare in Britain. Between 1970 and 1977, BMNH received a little over 1200 unspecialized enquiries relating to Macro- and Microlepidoptera (excluding Rhopalocera) from the public, commerce and public health departments in Britain. Ten of these involved *pellionella*: nine of the cases involved damage to carpets and the tenth involved damage to felt. The modern scarcity of *pellionella* outbreaks is probably due to a number of factors, among them higher standards of clothing hygiene, the use of synthetic, blended and moth-proofed fabrics, the widespread use of home insecticides and the fact that houses built in the post-war period are often hotter and less humid than older houses. The use of concrete rather than boards and cavities for floors has probably also made a difference to clothes-moth survival as skin dust and fibre fragments in a floor cavity provided a reservoir for infestation.

This species is an obvious candidate for transport by man. The existing populations of *pellionella* in the New World, Australia and New Zealand are here considered to be the result of introduction.

I have not succeeded in rearing *pellionella* in the laboratory although Chauvin (1977) has done so successfully, using pelts of musk-rat and small mammals (e.g. *Clethrionomys*) as a food source.

Attention is drawn here to the major study of the ecology of *pellionella* in a bulk wool store in Australia by Key & Common (1959).

PARASITES. Ichneumonidae: *Gelis cinctus* (L.) – W. Europe (det. Fitton, Robinson; Richards,

1949), *Hypsicera curvator* F. – N. America, W. Europe (Riley, 1890–1; Morley, 1930; Thompson, 1947; Richards, 1949; Woodroffe & Southgate, 1951a).

Braconidae: *Apanteles carpatus* (Say) – N. America, W. Europe (Marlatt, 1915; Ferrière, 1941; Burks, 1943; Thomson 1947; Woodroffe & Southgate, 1951a; Nixon, 1976), *Chremylus rubiginosus* (Nees) – N. America, W. Europe (Bruneteau, 1930; Morley & Rait-Smith, 1933; Thompson, 1947; Mason, 1948).

Pteromalidae: *Habrocytus semotus* (Walker) – W. Europe (Voukassovitch & Voukassovitch, 1931 – suggested to be *semotus* by Dr Z. Bouček).

Chalcidae: *Tetrastichus tineivorus* Ferrière [hyperparasite on *Apanteles carpatus*] – N. America (Burks, 1943 – as *T. carpatus* Burks).

The parasite records by Nagamori (1925) and Watanabe (1932) are considered to refer to *translucens* (q.v.) and the record by Brèthes (1920) is considered to refer to *murariella* (q.v.).

DISTRIBUTION. (Fig. 77.) Great Britain, France, Corsica, Germany, Austria, Switzerland, Italy, U.S.S.R. (European Region), India (highlands only), Sikkim, New Zealand, Canada, U.S.A. The following additional locality records from modern literature are here accepted as reliable: Norway, Sweden, Denmark, Finland (Rasmussen, 1964; Opheim, 1965; Krogerus *et alii*, 1971), Poland (Razowski & Sliwiński, 1961), Spain (Petersen, 1960; 1964d), Rumania (Căpușe, 1968), Hungary (Gozmány & Szöcs, 1965), Yugoslavia (Klimesch, 1968), Greece (Klimesch, 1968), U.S.S.R. (Ukraine, Caucasus) (Zagulajev, 1960), Mongolia (Zagulajev, 1972), China (Sinkiang) (Zagulajev, 1960), Australia (Key & Common, 1959). Records of *pellionella* from countries other than those listed above are considered unreliable or unproven: records from Syria, Asia Minor, Socotra, Madeira, the Canary Islands, lowland India, Sri Lanka (Ceylon) and Japan are specifically rejected (see 'Remarks').

MATERIAL EXAMINED

191 ex. (68 ♂, 46 ♀ genitalia preparations), living and preserved larvae, cases and pupae, one laboratory culture (from G. Chauvin).

Great Britain: 3 ex., Isle of Wight, Niton, 10.vii.1930 (*Fletcher*); 1 ♂, Hampshire, New Forest, Brockenhurst, 21.viii.1930 (*Fletcher*); 6 ex., Hampshire, Southampton, various dates 1932–1937 (*Fassnidge*); 1 ♂, Sussex, Tilgate, 24.vii.1922 (*Gardner*); 1 ♀, Sussex, Southbourne, 5.ix.1919 (*Gardner*); 1 ♂, Surrey, Mickleham, 5.vii.1853 (*Stainton*); 1 ♂, 1 ♀, Surrey, Redhill, 13.vii., 23.viii.1935 (*Rait-Smith*); 12 ex., Greater London, Bromley, various dates 1930–1947 (*Jacobs*); 5 ♀, Greater London, Bexley, various dates 1922–1931 (*Ford*); 1 ex., Greater London, Dartford Heath, 27.vi.1849 (*Stainton*); 1 ♀, Greater London, Richmond Park, Sidmouth Plantn, bred from nest of heron, 27.iv.1935 (*Collenette*); 1 ♂, Greater London, Richmond Park, 15.viii.1948 (*Bradley*); 1 ♀, 1 ♂, Greater London, Lewisham, 30.v.1880, vii.1887 (*Stainton*); 2 ex., Greater London, S.W.1, Eaton Square, 8.vii.1887; 3 ex., Greater London, W.11, Ladbroke Square, c. 1950 (*Meinertzhagen*); 3 ♂, Greater London, Ilford, vi.1974, 14, 15.vi.1975 (*Robinson*); 1 ♂, Greater London, Rainham, 10.vi.1976 (*Robinson*); 1 ♀, Essex, Maldon, ex 20% wool carpet, viii.1977 (*Sandford*); 1 ♂, Essex, Southend, 10.vii.1910 (*Whittle*); 9 ex., Gloucestershire, Stroud, various dates 1936–1942 (including 3 bred from birds' nests) (*Fletcher*); 1 ♀, Cambridgeshire, Chatteris, ex stuffed grebe, 6.vii.1921 (*Fryer*); 42 ex., Norfolk, Merton, various dates 1891–1907 (*Walsingham*, *Durrant*); 1 ♂, Northamptonshire, Clapton, 30.vi.1917 (*Gardner*); 1 ♂, Merseyside, Liverpool, 3.vii.1918 (*Tyerman*); 1 ♀, Cheshire, Sandbach, ex owl pellet, iii–iv.1976 (*Bowles*); 1 ♀, South Yorkshire, Sheffield, 20.vii.1848 (*Stainton*); 1 ♀, Tayside region, Pitlochry, 26.viii.1884 (*Stainton*); 1 ex., Tayside region, Blair Atholl, 13.vii.1882 (*Stainton*); 1 ♂, Highland region, Aviemore, 30.vi.1908 (*Bankes*); 1 ♂, Highland region, Lochinver, 7.viii.1921 (*Whittle*). **France:** 7 ex., Basses Pyrénées, St Pierre d'Irube, various dates 1936–1938 (*Adkin*); 1 ♂, Basses Pyrénées, Le Lac, St Jean de Luz, 1.vi.1931 (*Muspratt*). **Corsica:** 1 ♂, Bocognano, vi.1905 (*L.*). **Germany (West):** 1 ♂, Köln, 10.viii.1892. **Germany (East):** 8 ex., Grünhof, various dates 1870–1877 (*Zeller*); 1 ♂, Sömmerda [*Wocke*]. **Austria:** 1 ♀, Klosterneuburg, in garden, 1.vi.1915 (NM, Vienna); 1 ♀, Linz, 18.iv.1923 (*Knitschke*) (NM, Vienna); 1 ♂, Untersteiermark, Sanntaler Alps, Logar Valley, 7–900 m, 11–20.vii.1942 (*Zerny*) (NM, Vienna). **Switzerland:** 1 ♂, Montreux, 10.vii.1926 (*Fletcher*); 1 ♂, Bernese Alps, Grimmelalp, 1225 m, 7.vii.1925 (*Fletcher*); 2 ex., Bergün, 26.vii.1873 [*Zeller*]; 1 ♂, Engadin (*Frey*). **Italy:** 1 ♀, Toscana (*Fischer von Röslerstamm*). **U.S.S.R. (European region):** 3 ex., Kola Peninsula, Murmansk, Yukanski, 4, 18.viii.1917 (1 ex. 'on cottongrass') (*Cockayne*); 2 ex., Latvia ('Livon.') [*Lienig*]. **India:** 18 ex., Assam, Shillong, 1525 m, various dates 1918–1928 (including 1 ♀ paralectotype of *demirurga*)

(Fletcher). Sikkim: 2 ♂, Gangtok, 1850 m, v, 3.vi.1928 (Bailey). New Zealand: 2 ♂, Nelson, 26.–1923, 11.xii.1924 (Philpott) (1 ♂ in MARC, Auckland); 2 ♂, 1 ♀, Tisbury, 23.xi.1919, 29.i., 4.ii.1920 (MARC, Auckland); 1 ♂, Wellington, 31.xii.1879 (Meyrick). Canada: 2 ex., Newfoundland, St John's, ex fish meal, 13.xii.1961 (Morris); 4 ex., Newfoundland, Burgeo, ex fish meal, 27.iv., 17.v.1961 (Morris). U.S.A.: 1 ♂, Washington, Pullman, 9.viii.1932 (Clarke) (NMNH, Washington); 1 ♂, 3 ♀, Connecticut, New London, ex feather pillow, vi.1925 (Back) (NMNH, Washington); 1 ♂, California, Alameda County, 22.v.1908 (Pilate) (NMNH, Washington). 11 ex., no locality data, ex Zeller, Brown, Doubleday, Walsingham and Tyerman collections, BMNH.

Tinea translucens Meyrick

(Figs 1–3, 5, 7, 9, 11, 18–20, 31, 44, 51, 59, 78, 87–89, 102)

- Tinea translucens* Meyrick, 1917, *Exot. Microlepidopt.* 2: 78. Holotype ♀, PAKISTAN: Peshawar, v.1916 (Fletcher) (genitalia slide no. 13310; BMNH) [examined].
- Tinea metonella* Pierce & Metcalfe, 1934, *Entomologist* 67: 266. LECTOTYPE ♂ (abdomen and genitalia only), GREAT BRITAIN: Merseyside, Liverpool, [wool warehouse, 11 or 14.vii.1856] (Cooke) (genitalia slide no. Pierce 3206; BMNH), here designated [examined]. **Syn. n.**
- Tinea leonhardi* Petersen, 1957, *Beitr. Ent.* 7: 146, fig. 111. Holotype ♂, YUGOSLAVIA: Dalmatia, Castelnuovo, 3–11.v.1910 (Leonhard) (IP, Eberswalde) [not examined]. **Syn. n.**
- Tinea margaritacea* Gozmány, 1967, *Annl. Mus. r. Afr. cent.* 157: 14, fig. 13. Holotype ♂, ZAIRE: Lubumbashi [Elisabethville], iii.1936 (Seydel) (genitalia slide no. T-01; MRAC, Tervuren) [examined]. **Syn. n.**
- Tinea fortificata* Gozmány, 1968, *Acta zool. hung.* 14: 302, figs 2, 11. Holotype ♂, SOUTH AFRICA: Transvaal, Pretoria, 8.iii.1909 (Janse) (genitalia slide no. 14177; BMNH) [examined]. **Syn. n.**
- Tinea metonella* Pierce & Metcalfe; Pierce & Metcalfe, 1935: 95, pl. 58 [♂, ♀ genitalia]; Corbet & Tams, 1943b: 111, 143, figs 230, 257, 285, pl. 5, fig. 28 [identification; distribution; biology]; Ford, 1949: 184 [biology]; Bradley, 1966a: 217 [*leonhardi* synonymized]; Petersen, 1968: 98 [Germany (West); *leonhardi* synonymized; *metonella* removed from synonymy with *turicensis*]; Petersen, 1969: 374, figs 151, 160, 168 [♂, ♀ genitalia; biology; distribution; Germany (East) – Naumburg, Meissen]; Petersen, 1973a: 69 [Afghanistan]; Adams & Jacob, 1975: 7 [discovery in Britain – inaccurate account]; Hannemann, 1977: 220, pl. 17, fig. 9, figs 119a–b [identification; distribution; Germany (East)].
- Tinea leonhardi* Petersen; Petersen, 1959a: 568 [Afghanistan; ♂ genitalia]; Petersen, 1959b: 156 [Syria]; Zagulajev, 1960: 166, figs 128, 129 [U.S.S.R. – Caucasus, Turkmenia; description; ♂ genitalia]; Petersen, 1961b: 58 [Germany (East)]; Petersen, 1962: 201 [Yugoslavia, Malta]; Petersen, 1963a: 187 [Afghanistan]; Petersen, 1963c: 12 [Albania]; Petersen, 1964a: 116 [Iran]; Petersen, 1964c: 121 [Germany]; Căpușe, 1968: 323 [Rumania; ♂ genitalia].
- Tinea margaritacea* Gozmány; Gozmány & Vári, 1973: 50, fig. 109 [redescription].
- Tinea fortificata* Gozmány; Gozmány & Vári, 1973: 50, figs 105, 106 [redescription].
- [*Tinea pellionella* L.; Zeller, 1852: 157 (*partim* – 1 ♂, 2 ♀ and 'var. b' only); Walker, 1863: 468 (*partim* – specimens from Ceylon only); Moore, 1887: 500 [Ceylon]; Swinhoe & Cotes, 1889: 703 [Ceylon]; Meyrick, 1909: 361 [South Africa]; Fletcher, 1921: 190, pl. 56, fig. 2 [India]; Nagamori, 1925: 349 [Japan; parasite]; Matsumura, 1931: 1108, fig. [Japan]; Watanabe, 1932: 98 [Japan; parasite]; Yamada, 1940: 14 [Japan; biology]; Esaki *et alii*, 1953: 440, fig. 1184 [Japan]; Cheema, 1956: 167 [India; detailed study of biology]; Issiki, 1957: 16, pl. 2, fig. 41 [Japan; colour figure]; Okano, 1959: 276, pl. 182, fig. 30 [Japan; colour figure]. Misidentifications.]
- [*Tinea merdella* Zeller; Cooke, 1856: 125 [first British record]; Stainton, 1857: 102 [description]. Misidentifications.]
- [*Tinea pachyspila* Meyrick; Fletcher, 1914: 466, fig. 342 [poor figures of case, pupa and adult; India]. Misidentification.]
- [*Tinea turicensis* Müller-Rutz; Zagulajev, 1960: 164, figs 126, 127 [U.S.S.R. – Caucasus; ♀ genitalia]; Căpușe, 1968: 328, figs 171B, 171C (*partim* – ♀ only) [Rumania; ♀ genitalia]. Misidentifications.]

♂ (Fig. 87). 9–14 mm. Head light ochre. Maxillary palpus whitish, extending to just beyond second segment of labial palpus. Labial palpus ochreous white, densely flecked with blackish brown scales on outer surface. Galea extending to base of second segment of labial palpus. Antenna greyish brown, four-fifths length of fore wing. Thorax and tegula ochre, dusted with deep grey anteriorly. Fore wing ochreous, fringes concolorous, with distinct but diffuse basal fascia of dark grey scales, particularly dark at costa. Discal and plical spots small, elongate, dark grey; discocellular spot small, charcoal-grey. Hind wing ochreous white with a slight grey tint. Legs ochreous, fore leg and base of middle tibia grey above. Abdomen greyish ochre.

♀ (Figs 88, 89 [aberrant]). 11–18 mm. Coloration as ♂.

GENITALIA ♂. Saccus elongate, 0.94 ± 0.19 mm long. Valva (Fig. 44) with costa often markedly concave, apex rounded or slightly truncated at costal margin. Dorsal margin of gnathos concave, tip upturned towards tip of uncus. Anellus spines (Fig. 31) of rather variable form, commonly arranged in a broad, elongate band of twenty or more small spines. Aedeagus (Figs 18–20) elongate, 1.47 ± 0.27 mm long; tip without carinae; vesica with pair of distinctly blunt-tipped blade-shaped cornuti and at least four small, elongate terminal cornuti. In some individuals, small cornuti connected by zone of sclerotization to wall of aedeagus [see 'Morphology']. In specimens from Japan, number of terminal cornuti often very large, frequently exceeding ten. Aedeagus/saccus ratio 1.58 ± 0.35 .

GENITALIA ♀. Eighth sternite with deep, narrow V-shaped emargination and distinct sclerotized lateral patches at base of emargination (Fig. 59). Posterior region of antrum with rhomboidal outline, transverse folds of wall convergent at ostium; longitudinal folds transversely divided in posterior half. Anterior limit of antrum with more or less clearly-defined annular sclerotization appearing as transverse stripes at posterior end of ductus bursae. Corpus bursae (Fig. 51) with two conspicuous needle-shaped signa, each arising from one side of a short, broad, blade-shaped base set in large, circular sclerotized base-plate. Sclerotization of signum base-plates uneven, giving each base-plate irregular edge and mottled appearance.

REMARKS. *Tinea translucens* closely resembles *pellionella* in its external characteristics and cannot be reliably separated from it except by examination of the genitalia. The two large cornuti of the male are blunter than in *pellionella* which also lacks the apical group of small cornuti always present in *translucens*. The dorsal margin of the gnathos is concave, not straight as in *pellionella* and the aedeagus is straight whereas in *pellionella* it is distinctly banana-shaped. Females of *translucens* have a much larger antrum than females of *pellionella* and the eighth sternite is more deeply emarginate. The signa, apparently always a pair in *translucens*, are frequently more numerous in *pellionella*: the signum base-plates of *pellionella* do not have the characteristic irregular edge and mottled appearance of those of *translucens* and the bases of the needle-shaped signa are usually shorter and broader in *pellionella* than in *translucens*.

Specimens of *translucens* from Japan, while agreeing with material from elsewhere in all other characteristics, have a larger number of small cornuti at the tip of the aedeagus, usually about twelve, whereas non-Japanese specimens have about half this number.

The specimen illustrated in Fig. 89 is aberrantly marked, having a dense basal field of blackish scales in the fore wing.

Previous workers on this group have overlooked entirely the existence of the name *translucens* and the holotype in BMNH. This is due to the cryptic nature of the original description and the state of the holotype which is flecked with particles of carbon and is slightly greasy.

The placing of *Tinea metonella* Pierce & Metcalfe as an erroneous synonym of *Tinea turicensis* Müller-Rutz by Petersen (1957: 148 *et seq.*) and Rasmussen (1964: 337) occurred because these authors both examined the male genitalia preparation of *dubiella* in the Pierce collection (Pierce slide no. 3208; BMNH) labelled '*metonella*'. Pierce's slide 3206, clearly labelled 'TYPE/Cooke Col. Liverpool' is a specimen of *translucens* and there is no evidence that slide no. 3208 is a syntype. This error of identification was corrected by Bradley (1966a: 217) and the correction followed by Petersen (1968: 98 *et seq.*). Petersen had already, however, described *leonhardi*, having been misled by being provided with the wrong slide from the Pierce collection. Petersen's misidentification was followed by Zagulajev (1960: 164) who complicated matters further by figuring the female genitalia of *translucens* as *turicensis*. Gozmány's two further synonyms of *translucens* are each based on specimens of both sexes: the original descriptions are accompanied by figures of remarkable crudity.

The description of '*Tinea metonella*' by Kudrjajtseva (1975: 621, figs 3A, 3B) is here considered to refer to *murariella*. She illustrates and mentions the fairly frequent occurrence of a group of three signa: I have seen no example of *translucens* with three signa whereas in *murariella* about 20% of individuals examined have three signa.

Tinea translucens is the '*Tinea merdella* Zeller' of Cooke (1856) and Stainton (1857): the description by the latter author has been traditionally attributed to *Tinea flavescens* Haworth (q.v.) but is based on Cooke's specimens which are *translucens*.

BIOLOGY. This species appears to be able to utilize much the same range of foodstuffs as *pellionella* which it replaces in warmer climates, filling the same synanthropic niche. *Tinea translucens* has

been consistently misidentified as *pellionella* in the humid tropics and appears to be the primary agent responsible for moth damage in these areas. There are no records of *translucens* being found (except as an adult) in non-domestic circumstances. Specimens have been bred from woollen clothing, 'oriental' carpets, blankets, a leather shield and from bongo drums made from zebra-skin. Silk headbands of books imported from Malaysia were found to have been damaged by a case-bearing larva which I consider to have been of this species. In the laboratory, *translucens* will feed on feathers, wool, leather and fish-meal; large larvae are able to eat hair as coarse as that of a human beard.

Tinea translucens is a cosmopolitan species which is apparently common in the humid tropics. It ranges northward as far as Virginia (U.S.A.), Liverpool (England) and Tokyo (Japan) and southward as far as Quillota (Chile) and Cape Town (South Africa) but at its latitudinal extremes, in the north at least, it is entirely restricted to a synanthropic indoor existence in artificial warmth and shelter.

I consider that the study of the bionomics of '*Tinea pellionella*' published by Cheema (1956) is really of this species. The source of Cheema's material was Kanpur, Uttar Pradesh, India, well out of the range of *pellionella* and well within the range of *translucens*. Cheema found that eggs hatched after an incubation period of four to seven days but hatching only occurred at temperatures between 21 and 32 °C: outside this range all eggs died. Cheema's measurements of the length and width of newly hatched larvae are remarkable for their degree of precision (to 0.001 mm) and it would be of interest to know the technique used for such measurements: the figures given for standard error are equally remarkable (less than 1.5% of the mean) and may represent a typographic error. Larvae developed satisfactorily at 21–32.5 °C and died at temperatures outside this range. Fastest development (33 days from hatching to pupation) occurred at 25 °C and 90% R.H. The comments above regarding newly-hatched larvae are also applicable to Cheema's measurements of fully grown larvae. Larvae passed through five to twelve instars, five instars being observed in all larvae reared at 25 °C and the larger numbers of instars occurred at the highest non-lethal temperatures. The pupal period was found to be about 10 days at 25 °C. Copulation (lasting about 30 minutes) was found to occur within 12 hours of emergence, oviposition beginning a day and a half later and continuing for about four days. Females were found to lay between eight and 83 eggs, larger females laying more eggs than small females. Adult life-spans were found to be in the range of three to seven days, rather short compared with those recorded for *Tineola* by Titschack (1920). Males were shorter-lived than females (the contrary was found in *Tineola*). The cultures used in Cheema's experiments yielded a predominance of females (which were more than twice as abundant as males) and this may account for the phenomenon of reduced male longevity, it being possibly caused by multiple copulation (Titschack found that copulation reduced male longevity in *Tineola*).

Cheema's observations accord closely with mine. Six laboratory cultures of *translucens* are currently maintained in BMNH; one of these was obtained in 1973, and the others are more recent acquisitions. Cultures are stored at a temperature of about 25 °C in which the generation time is about three months. The behaviour of all stages seems similar to that observed by other authors in *pellionella* but Cheema records and I confirm that case-building does not begin immediately after hatching: newly hatched larvae wander a great deal before they begin case-building and feeding, and this dispersive first day of larval life is a problem with cultured material as larvae are able to pass through very narrow apertures and escape from most types of container.

Since the beginning of 1970, BMNH has received 15 reports of outbreaks of *Tinea translucens* in Britain (for details of enquiries, see p. 77, 'Biology' of *pellionella*). Thirteen of these outbreaks involved damage to zebra-skin bongo drums imported into Britain from East Africa or South Africa and in several cases infestation had spread from the drums to carpets or clothing. The fourteenth outbreak involved a souvenir 'Zulu' shield from East Africa (damage to leather and hair) and the fifteenth was a large outbreak in a shop selling woollen goods imported from Peru. In all cases, outbreaks occurred in warm buildings with central heating, conditions in which *pellionella* is rarely found.

Carriage and importation of *translucens* by man seems to be frequent as exemplified by its

recent outbreaks in Britain. Further examples were intercepted by the Ministry of Agriculture, Fisheries and Food in 1976 in a cargo of Argentinian sheepskins imported into Britain. The type-series of *metonella* was found in a warehouse with imported wool.

Tinea translucens is, with *Tinea murariella*, extremely simple to rear in the laboratory and, with suitable safeguards taken to prevent pest outbreaks, is a potentially valuable laboratory animal for use in education. Our cultures are set up in transparent plastic boxes (12 × 18 cm and 6 cm deep) with tight-fitting lids. The boxes are sealed with adhesive tape to prevent the escape of newly hatched larvae. The food provided is old woollen clothing (socks or pullovers cut into small strips) sprinkled with fishmeal containing 10% yeast powder. After several generations the contents of the box are reduced to a layer of frass topped with a layer of old larval cases and adult bodies. Living larvae will recycle their ancestors and their cases for a while, producing dwarfed adults which appear to have a longer development time than adults which, as larvae, were provided with fresh food. Cultures reduced to this condition will maintain themselves for only a short time and subcultures should be established in a new box with fresh food. We usually manipulate our cultures of this species during the winter when they can be taken outdoors and cooled so that adults do not move and there is little danger of producing secondary infestations.

PARASITES. Ichneumonidae: *Hypsicera curator* F. – W. Europe (det. Fitton, Robinson).

Braconidae: *Apanteles carpatus* (Say) – Japan (Watanabe, 1932 – as *A. igae* Watanabe on '*pellionella*'), *Chremylus rubiginosus* (Nees) – Japan (Nagamori, 1925 – as *Paramesocrina tineavora* Nagamori on '*pellionella*').

DISTRIBUTION. (Fig. 78.) Great Britain, Germany (East), Austria, Sicily, U.S.S.R. (S. Russia), Tunisia, Egypt, Pakistan, India, Kashmir, Sri Lanka, Japan, Zaire, Rhodesia, South Africa, U.S.A., Chile. The following additional locality records from the literature are here accepted as reliable: Germany (Petersen, 1968), Malta (Petersen, 1962), Rumania (Căpușe, 1968), Albania (Petersen, 1963c), Yugoslavia (Petersen, 1957), U.S.S.R. (Turkmenistan) (Zagulajev, 1960), Syria (Petersen, 1959b), Iran (Petersen, 1964a), Afghanistan (Petersen, 1963a).

MATERIAL EXAMINED

388 ex. (46 ♂, 38 ♀ genitalia preparations), living and preserved larvae, cases and pupae (including laboratory cultures).

Great Britain: 32 ex., Isle of Wight, Yarmouth, ex African hide drum, culture 1, 1974; 60 ex., Greater London, Staines, ex hide drum from S. Africa, culture 2, 1974; 64 ex., Berkshire, Slough, Pest Infestation Control Laboratory stock, ex African hide drum, culture 3, 1974; 43 ex., Sussex, Horsham, ex Kenyan drum, culture 4, 1975; 60 ex., Greater London, S.W.1, ex woollens from Peru, BMNH culture, 1975; 42 ex., 4 cases with pupae, Essex, Basildon, ex African drums, BMNH culture 6, 1977; 2 ex., Greater London, Staines, ex skin drum from South Africa purchased vii.1973, emerged 7.i.1974 (*Pestridge*) [same source as culture 2]; 2 ex., ex larva on E. African bongo drums, 1974; 16 ex., Greater London, W.8, Commonwealth Institute, from W. Indian ceremonial dress, 16.ix.1965 (*Bradley*); 1 ♀ (abdomen and genitalia only), data as lectotype of *metonella* (Pierce slide no. 3206; BMNH) (paralectotype of *metonella*). **Germany (East):** 3 ♂, 1 ♀, Grünhof, 15., 24.vi.1872 (*Zeller*); 1 ♀, Ober-Lausitz, Niesky, 19.vi.1857 (*Christoph*). **Austria:** 1 ♂, 1 ♀, Wien, ex larva, 14.vi.1889 (*Hornig*) (NM, Vienna); 1 ♀, Linz, 18.iv.1923 (*Knitschke*) (NM, Vienna). **Sicily:** 1 ♂, Siracusa, 8.v.[1844] (*Zeller*). **U.S.S.R. (S. Russia):** 1 ♀, Krasnoarmeysk ('Sarepta'), 13–14.viii.1858 (*Christoph*). **Tunisia:** 1 ♂, Sfax, 6.vi.1950 (*Bédé*). **Egypt:** 1 ♀, Siwa, 26.iv.1935 (*Omer-Cooper*). **India:** 2 ♀, Uttar Pradesh, Dehra Dun, ix.1931, 6.viii.1936 (*B. Graham*); 1 ♀, Punjab, Seraj Range, 9.ix.1923 (*R. O.*); 1 ♂, Uttar Pradesh, Kumaun, Mukteswar, 2125 m, 8.v.1923 (*Fletcher*); 2 ♀, Madras, Coimbatore, 5.xi.1913, ix.1916 (*Fletcher*); 2 ex., Madras, Coimbatore, bred from woollen clothes, 24.viii.1916 (*Ramakrishna*); 1 ♂, Uttar Pradesh, Naini Tal, 2000 m, 12.vi.1934 (*Graham*); 1 ♂, Madras, Shevaroy Hills, 1375 m, xii.1913 (*Fletcher*); 2 ♂, Punjab, Simla, v.1918 (*Fletcher*); 6 ex., Bengal, Bihar, Pusa, iii, iv.1912 (bred from wool), 23.ii.1923, 28.x.1923 (feeding on blanket) (*Fletcher*). **Kashmir:** 1 ♀, Srinagar, 1575 m, 2.x.1923 (*Fletcher*). **Sri Lanka:** 7 ♂, 4 ♀, Kan district, Kandy, ex Persian carpet, iii.1970 (*Pereira*) (NMNH, Washington). **Japan:** 2 ♂, Tokyo, 13.vi, 14.vii.1932 (*Issiki*) (1 ♂ in NMNH, Washington); 1 ♂, Taihoku, 19.xi.1933 (*Issiki*) (NMNH, Washington); 1 ♂, Honsyū, Osaka, 11.vii.1954 (*Issiki*) (NMNH, Washington); 2 ♀, Honsyū, Osaka, ex wool, 20.xi.1971 (*Moriuti*); 2 ♂, 2 ♀, Honsyū, Osaka, Moriguti, 10, 19.x.1973 (*Saito*) (1 ♂, 1 ♀ in UOP, Osaka); 6 ex., Honsyū, Osaka, Moriguti, 15–19.iv.1974 (*Saito*) (2 ex. in UOP, Osaka). **Rhodesia:** 5 ex., Salisbury, 1894 (*Marshall*).

South Africa: 1 ♀, Cape Province, Simonstown, 1946 (*Hunt*); 2 ex., Natal, 3, 4.v.1879 (*Wocke*); 1 ♂, Capetown, 1907 (L.). **Africa:** Mam'a, iii.1872 (*Christoph*). **U.S.A.:** 2 ♂, 2 ♀, Virginia, McLean, ex leather shield, 8.vi.1970 (*Davis*) (NMNH, Washington). **Chile:** 2 ♂, Quillota, i. (*Silva*) (NMNH, Washington). **Incomplete Data:** 1 ♀, 'Pellionella L., Z.L.E. [Zeller – Linn. ent.] 6: 157' / Zeller Coll.; 1 ♀, 'Wshtr. lit. X.48' [Wiesenhütter – letter of October 1848] / Zeller Coll.; 1 ♂, 'Pellionella var. b. H.15. [Hübner fig. 15] H.S. 278 [Herrich-Schäffer fig. 278]' / Zeller Coll.

Tinea murariella Staudinger

(Figs 1, 2, 10, 21–23, 32, 33, 45, 52, 60, 79, 90, 91)

Tinea murariella Staudinger, 1859, *Stettin. ent. Ztg* 20: 235. Lectotype ♀, SPAIN: Cadiz, Chiclana, bred from chalk and dust cases on house walls, 5 May (*Staudinger*) (genitalia slide [Agenjo]; MNHU, Berlin), designated (as holotype) by Agenjo (1952: 345) [examined].

Tineola bipunctella Ragonot, 1874, *Bull. Soc. ent. Fr.* 1874: clxxi. LECTOTYPE ♀, SPAIN: Barcelona, bred from debris of *Charaxes* wings, 25.vi.1871 (genitalia slide no. 2402 [Viette]; MNHN, Paris), here designated [examined]. [Synonymized by Amsel (1955: 63).]

Tinea murariella Staudinger; Wocke, 1861: 107 [catalogue]; Stainton, 1869: 143 [description]; Wocke, 1871: 270 [catalogue]; Hofmann, 1875: 71 [Spain – Andalusia]; Seebold, 1879: 125 [Spain – Bilbao]; Seebold, 1898: 162 [Spain – Bilbao]; Rebel, 1901: 240 [Spain; Sicily; Yugoslavia]; Zerny, 1927: 486 [Spain – Albarracín]; Kautz, 1928: (76) [Spain – Andalusia]; Müller-Rutz, 1932: 263 [Switzerland – as *Tineola murariella*]; Agenjo, 1952: 62, pl. 9, figs 2, 2a, 2b, 3 [description; ♂ genitalia; Spain]; Amsel, 1955: 63, pl. 6, fig. 7 [*bipunctella* synonymized; ♂ genitalia; Spain]; Petersen, 1957: 149, fig. 115 [♀ genitalia]; Petersen, 1959a: 569, fig. 14 [♂ genitalia]; Petersen, 1960: 227 [Spain]; Lhomme, 1963: 1100 [France]; Petersen, 1963b: 414 [bred from raptor pellets, Sudan]; Petersen 1964d: 404, 417 [Spain]; Petersen, 1967: 358 [Spain]; Căpușe, 1968: 334, figs 174, 175A–D [Rumania]; Hicks, 1971: 178 [erroneous birds' nest record]; Chauvin, 1977: 1 [detailed and important study of biology; comparison with *pellionella*].

Tineola bipunctella Ragonot; Ragonot, 1875: 579, pl. 11, fig. 1 [description; figure]; Rebel, 1896: 125 [Canary Is]; Rebel, 1901: 240 [Spain; Mauretania; Tenerife]; Walsingham, 1908: 1026 [North Africa; Canary Is]; Rebel, 1910: 367 [Canary Is]; Rebel, 1917: 62 [Tenerife]; Kautz, 1928: (76) [Andalusia]; Amsel, 1955: 63 [synonymized with *murariella*].

[*Tinea pellionella* L.; Stainton, 1867a: 4, 10, 27 [Syria; Asia Minor; reference to *murariella* doubtful – specimens not seen]; Rebel, 1907: 99 [Socotra; reference to *murariella* doubtful – specimen not seen]; Brèthes, 1920: 286 [Argentina; parasite]; Silvestri, 1943: 102, figs 121–126 [biology]; Biezanko *et alii*, 1957: 16 [Uruguay]. Misidentifications.]

[*Tinea metonella* Pierce & Metcalfe; Kudrjajtseva, 1975: 621, fig. 3 [U.S.S.R. – Adzhar; development times]. Misidentification.]

♂ (Fig. 90). 8–12 mm. Head yellow-ochre. Maxillary palpus whitish, almost reaching tip of second segment of labial palpus. Labial palpus ochreous, whitish on inner surface, outer surface flecked with greyish brown. Galea reaching one-third length of second segment of labial palpus. Antenna dark greyish brown, almost reaching apex of fore wing. Thorax and tegulae yellow-ochre, greyish brown anteriorly. Fore wing light yellow to greyish ochre, fringes concolorous, base of costa greyish brown. Discocellular spot small, brown to dark grey-brown; discal and plical spots ill-defined or obsolete in pale specimens (with high magnification a few dark plical scales can usually be found) but well-defined in dark specimens. Hind wing pale greyish, fringes paler, ochreous cream. Legs cream to ochreous, fore legs dusted above with dull brown. Abdomen light greyish brown.

♀ (Fig. 91). 11–17 mm. Coloration as ♂.

GENITALIA ♂. Saccus elongate, 0.89 ± 0.18 mm long. Valva (Fig. 45) with apex rounded or slightly truncated at costa. Dorsal margin of gnathos straight in middle, concave at base and tip. Anellus spines (Figs 32, 33) small and flat, forming an elongate row three or four spines wide; about 20 spines in each row heavily sclerotized; unsclerotized plaques extend distally along anellus almost to level of tip of gnathos (when anellus fully 'unrolled' posteriorly after removal of aedeagus). Aedeagus (Figs 21–23) 1.33 ± 0.27 mm long; tip without carinae; vesica ornamented only with two blade-shaped cornuti: tips of cornuti acutely pointed, diagonal edge usually coarsely serrate with one or two lateral spine-like projections. [In one example seen, tips of cornuti are smooth and tapered – Fig. 23.] Aedeagus/saccus ratio 1.51 ± 0.12.

GENITALIA ♀. Eighth sternite with deep, narrow V-shaped emargination (Fig. 60). Posterior region of antrum swollen equatorially at level of transverse folds which do not converge towards ostium; longitu-

dinal folds transversely divided in anterior half. Anterior limit of antrum with clearly defined annular sclerotization appearing as transverse stripes at end of antrum. Corpus bursae (Fig. 52) with two or three conspicuous needle-shaped signa, each arising from one side of a short, broad, blade-shaped base set in a large, circular, well-sclerotized base-plate. Sclerotization of signum base-plate even, giving each base-plate regular edge and evenly coloured appearance.

REMARKS. *Tinea murariella* closely resembles *T. translucens* both in external appearance and in genital structure, particularly of the female. The discal and plical spots are usually not as well developed as in *translucens* and the colour of the fore wings is generally lighter. There are no carinae on the aedeagus of *murariella* and the vesica is ornamented only with two large blade-shaped cornuti: the serrated tips of these cornuti are characteristic but not always present. The small terminal cornuti of *translucens* are always absent in *murariella*. Females of *murariella* may have two or three signa – *translucens* always has two – and these are set in base-plates which are evenly and densely sclerotized: in *translucens* the base-plates have mottled sclerotization, which gives them an irregular edge. Transverse division of the longitudinal antrum folds occurs much further anteriorly in *murariella* than in *translucens* and the transverse folds in the posterior (swollen) region of the antrum do not converge on the ostium as in *translucens*. In *murariella* there is a small longitudinal mark at either side of the anterior end of the emargination of the eighth sternite: this is a small fold in the inner wall of the antrum and is absent in *translucens*.

The fore wing colour of laboratory-reared specimens of *murariella* is comparable with that of *translucens* but wild-caught specimens are generally paler and may be quite bright pale yellow. The density of fore wing coloration is more variable in *murariella* than in other species of the *pellionella*-group.

The males referred to by Ragonot (1875 : 579) are not syntypes as they were obtained after the publication of the original description. The female designated here as lectotype may have been the only specimen described by Ragonot in 1874 – his description makes no mention of the number of specimens he had. There are now no specimens of *bipunctella* in the Ragonot collection apart from the lectotype (Viette – *pers. comm.*).

The illustrations and description of Silvestri (1943 : 102) are here considered to refer to *murariella* and not *pellionella* and the record of '*Tinea metonella*' by Kudrjajtseva (1975) is also considered to be of this species. The records of '*pellionella*' by Stainton (1867*a*), Rebel (1907), Brèthes (1920), and Biezanko *et alii* (1957) are considered likely to refer to *murariella* but substantive specimens have not been examined. The illustrations of the aedeagus of this species by Petersen (1959*a*) and Căpușe (1968) show the surface of the cornuti as distinctly abrasive, with closely-packed small, thorn-like projections covering the ends. I have not observed cornuti of this type: in the 18 preparations I have examined the cornuti have serrations restricted to the region of the oblique edge of the cornutus and the side of the cornutus may have one or two spine-like projections.

The records of this species from Venice (Petersen, 1961*c* : 531) and the Yemen (Petersen, 1961*a*) are erroneous and are referable to *messalina* (q.v.).

BIOLOGY. This species appears able to utilize much the same range of foodstuffs as *pellionella* and *translucens*; it is a synanthrope and a pest. I have examined specimens of *murariella* reared from fur, woollen clothing, hides, hooves and insect specimens and there is a reliable literature record (Petersen, 1963*b* : 414) of its being reared from raptor pellets. Larvae (and pupae) have been collected from house walls in Spain: larvae might have been feeding on horsehair plaster. In the laboratory, *murariella* will eat wool, coarse hair, feathers, leather and fish-meal.

Tinea murariella is primarily a Mediterranean species ranging eastward as far as Sudan and northward as far as southern France and Rumania. It is present on several of the Atlantic islands and is recorded from the east coast of South America. It is likely that it is an introduction to the Neotropical region.

This species was first reared in the laboratory by Chauvin (1977). His stock originated in Brazil and was intercepted on hides imported into France: a subculture of Chauvin's stock is now maintained in BMNH. Chauvin found that, under laboratory conditions, *murariella* produced four generations per year but outdoors in western France the culture was univoltine and only survived

the winter in mild years. The life-cycle and the duration of its stages is similar to that observed in *pellionella* and *translucens* under similar conditions. Chauvin (1977) found that for *pellionella*, the optimal humidity for larval development was 50% with mortality increasing with deviation from 50%. In *murariella*, a humidity of 50–100% was optimal and very high mortality occurred at low humidities, there being no survival at all at 10% R.H. or less. Chauvin gives a detailed study of water conservation in this species and compares its adaptations and survival in dry conditions with those of *pellionella*. My observations of *murariella* emphasize its similarity in behaviour and appearance in culture to *translucens*.

Wolff (*pers. comm.*), while collecting in Madeira, found a pupa of *murariella* buried in loose soil some way from human habitation. It is conceivable that this specimen originated from a bird pellet.

This species may be a commoner and more frequently carried pest than is presently realized. Chauvin's cultures came from a cargo of Brazilian hides and the only specimen recorded from Britain was intercepted in a cargo of hooves. Like *translucens*, *murariella* is fecund and successful at the normal temperatures of centrally heated premises in temperate regions.

Rearing of *murariella* in the laboratory is accomplished in exactly the same way as described above for *translucens*.

PARASITE. Braconidae: *Apanteles riograndensis* Brèthes – S. America (Brèthes, 1920 – on '*pellionella*').

DISTRIBUTION. (Fig. 79.) Great Britain (one interception only), France, Portugal, Spain, Canary Islands, Madeira, Azores, Morocco, Algeria, Egypt, Venezuela, Argentina, Brazil. The following additional locality records from the literature are here accepted as reliable: Rumania (Căpușe, 1968), U.S.S.R. (Adzhar) (Kudrjavitseva, 1975), Sudan (Petersen, 1963*b*).

MATERIAL EXAMINED

Great Britain: 1 ♀ (genitalia slide only), Strathclyde region, Glasgow, Princes Dock, SS *Empire Newton*, ex hooves from Argentina, i.1946 (*Salmond*). **France:** 1 ♀, Hyères, in hotel, 26.xi.1932 (*Fletcher*); 1 ♀, St Jean de Luz, 28.viii.1951 (*Adkin*); 1 ♀, 'S. France', 1884 (*Ragonot*); 134 ex., Marseilles, ex hides originating from S. Brazil [Rio de Janeiro or São Paulo] (*Chauvin*) BMNH culture (4 ex. in NMNH, Washington). **Portugal:** 1 ♂, Porto, Marco (*Wattison*). **Spain:** 2 ex., 4 cases, 1 larva, Granada, on walls of house, 28.v, 19.vii.1901 (*Walsingham*); 1 ♂, [Cadiz, Chiclana, bred from chalk and dust cases on house walls, v.] (*Staudinger*) (genitalia slide [Agenjo]; MNHU, Berlin) (paralectotype of *murariella*). **Canary Islands:** 1 ♀, Tenerife, Guimar, ex larva on walls, 2.vi.1907 (*Walsingham*); 2 ♂, Tenerife, Sta Cruz, 22, 25.i.1907 (*Walsingham*); 1 ♂, Tenerife, Pto Orotava, 3.v.1907 (*Walsingham*); 1 ♂, Tenerife, Playa de las Américas, 17.viii.1977 (*Tuck*). **Madeira:** 1 ♀, ex Bethune-Baker coll.; 1 ♂, Deserta Grande, ex case in soil, 22.iv.1974 (*Wolff*) (coll. Wolff, Copenhagen). **Azores:** 1 ♂, Flores, Sta Cruz, 16–30.vi (*Storå*) (ZMU, Helsinki). **Morocco:** 7 ex., Tangiers, 4, 18.xii.1901, 5.iv, 1, 9, 20.v.1902, 27.v.1930 (*Walsingham*, *Fletcher*). **Algeria:** 4 ex., Prov. Oran, Sidi-bel-Abbès, 18, 22.vi, 2.ix.1917 (*Rotran*). **Egypt:** 1 ♀, Aswan, 1920 (*Hayward*); 1 ♀, ex larva damaging overcoats in Police stores, 9.iv.1918 (*Alfieri*) (NMNH, Washington). **Venezuela:** 1 ♀, Caracas, El Valle, reared from fur, 14.viii.1941 (*Ballou*) (NMNH, Washington). **Argentina:** 1 ♀, Buenos Aires (*Areco*)/Montevideo Parasit. Lab., museum pest, 20.viii.1942 (*Silveira*) (NMNH, Washington); see also Great Britain. **Brazil:** see France.

Tinea lanella Pierce & Metcalfe

(Figs 1, 2, 12, 25, 35, 36, 49, 53, 64, 92, 93)

Tinea lanella Pierce & Metcalfe, 1934, *Entomologist* 67: 267. LECTOTYPE ♂ (abdomen and genitalia only), [GREAT BRITAIN: Merseyside, Liverpool, wool warehouse, vi–vii.1922 (*Mansbridge*)] (genitalia slide no. Pierce 3204; BMNH), here designated [examined].

Tinea lanella Pierce & Metcalfe; Pierce & Metcalfe, 1935: 95, pl. 58 [♂, ♀ genitalia]; Ford, 1949: 184 [biology]; Agenjo, 1952: 61 [erroneously placed as a synonym of *pellionella*]; Petersen, 1957: 146, figs 112, 113 [genitalia]; Zagulajev, 1960: 164 [description]; Petersen, 1960: 227, fig. 7 [♂ genitalia; Spain]; Petersen, 1964*d*: 417 [Spain]; Căpușe, 1968: 335, figs 176A–C [Rumania; ♂, ♀ genitalia]; Bradley *et alii*, 1972: 8 [checklist].

♂ (Fig. 92). 11–15 mm. Head ochreous cream. Maxillary palpus whitish, reaching tip of second segment of labial palpus. Labial palpus pale ochre, whitish on inner surface, outer surface flecked with brown. Galea reaching to between base and one-quarter length of second segment of labial palpus. Antenna light brownish ochre, three-quarters or more length of fore wing. Thorax and tegula light ochre, suffused anteriorly with blackish brown. Fore wing light ochre, fringes concolorous, base of costa suffused blackish brown. Discocellular spot light greyish brown, small; discal and plical spots yellowish brown, small, ill-defined. Hind wing greyish with slight ochreous tint at margin, fringes paler. Legs light ochreous, fore legs dusted above with dull brown.

♀ (Fig. 93). 14–17 mm. Coloration as ♂.

GENITALIA ♂. Saccus 0.87 ± 0.23 mm long. Valva (Fig. 49) with costa markedly concave to about two-thirds, apex truncated. Dorsal margin of gnathos straight in middle, markedly concave at base and tip. Anellus spines (Figs 35, 36) very small, arranged in a patch of only 12–14 widely separated spines. Aedeagus (Fig. 25) 1.32 ± 0.07 mm long, two large serrate comb-shaped carinae at or just below tip; vesica ornamented with two elongate, evenly tapered cornuti. Aedeagus/saccus ratio 1.55 ± 0.45 .

GENITALIA ♀. Eighth sternite with shallow, square emargination with anterior nick, ventral lip of ostium heavily sclerotized on internal surface (Fig. 64). Antrum small, slightly bulbous, transverse folds of posterior internal wall absent, longitudinal folds ill-defined, not transversely divided. Wall of ductus bursae with sclerotization just anterior to end of antrum, forming an even band, not annular stripes. Posterior third of ductus bursae finely scobinate. Corpus bursae (Fig. 53) with one or two very small, short, needle-like signa set off-centre in a small, pimple-like sclerotized base.

REMARKS. *Tinea lanella* differs, in the male, from other members of the *pellionella*-group in possessing a pair of large, comb-shaped carinae just below the tip of the aedeagus. The two large cornuti are somewhat similar to those of *messalina* or *murariella* but these two species have no carinae. Females differ from other members of the *pellionella*-group (with the exception of *bothniella*) in having the posterior region of the ductus bursae finely scobinate. In *bothniella* the membrane of the ductus bursae is coarsely scobinate and in all other members of the *pellionella*-group it is smooth. The signa of *lanella* are smaller than those of any other species with two signa: no other *pellionella*-group species is known which may have only one signum. The shape and sclerotization of the eighth sternite and antrum of *lanella* are distinctive.

Pierce & Metcalfe (1934) differentiated this species on the basis of its having only one signum: their observations are based on Pierce's two slides (nos 3203, 3204) of *lanella*. A subsequent preparation (slide no. 1327; BMNH) clearly shows two signa of the same kind as in Pierce's preparations.

Apart from the type-series of this species, only three other specimens are known, two males from Burgos, Spain (Petersen, 1960) and a male from Bucharest, Rumania (Căpușe, 1968).

In the figure of the genitalia of a male *lanella* from Spain by Petersen (1960: fig. 7), the comb-shaped carinae appear to be retracted into the aedeagus. The three males from the type-series which have been dissected all have a spermatophore partly extruded from the tip of the aedeagus, the vesica is partly everted and the cornuti protrude from the aedeagus. The male illustrated by Căpușe (1968: fig. 176A) shows similar extrusion of a spermatophore and so Petersen's specimen is the only one known in which the genitalia are in a normal state. In specimens examined, however, the comb-shaped carinae are set in the heavily sclerotized wall of the aedeagus and could not be retracted into the aedeagus. The orientation of the carinae in Petersen's figure leads me to believe they are on the outside of the aedeagus but may be within the anellus in his preparation.

BIOLOGY. The type-series of *lanella* was from a wool warehouse in Liverpool and contains specimens bred from wool although Pierce & Metcalfe (1934) are not specific on this point. The rarity of *lanella* makes pointless any guess at the natural biotope of this species. Adults have been collected in June and July.

The presence of *lanella* in a wool warehouse suggests that it may have been imported with raw wool but the source of the Liverpool specimens is unknown.

DISTRIBUTION. Great Britain. The following additional locality records from the literature are here accepted as reliable: Spain (Petersen, 1960), Rumania (Căpușe, 1968).

MATERIAL EXAMINED

17 ex. (3 ♂, 3 ♀ genitalia preparations).

Great Britain: 1 ♀ (abdomen and genitalia only) [Merseyside, Liverpool, wool warehouse, vi-vii.1922] (*Mansbridge*) (genitalia slide no. Pierce 3204); 1 ♂, 1 ♀ (abdomen and genitalia only) [Merseyside, Liverpool, wool warehouse, vi-vii.1922] (*Tyerman*) (genitalia slide no. Pierce 3203); 1 ♂, Merseyside, Liverpool (*Pierce*) (abdomen missing); 7 ♂, 9 ♀, Merseyside, Liverpool, bred [from wool warehouse], vi-vii.1922 (*Tyerman*) (all paralectotypes of *lanella*).

Tinea messalina sp. n.

(Figs 1, 24, 34, 48, 54, 63, 94, 95)

[*Tinea murariella* Staudinger; Petersen, 1961a: 65; Petersen, 1961c: 531. Misidentification.]

♂ (Fig. 94). 12 mm. Head light ochre. Maxillary palpus whitish. Labial palpus whitish, densely flecked with dark brown on outer surface. Galea not visible—head preparation not made owing to lack of material. Antenna greyish brown, extending to tip of fore wing. Thorax and tegula light ochreous flecked with brown, dark brown anteriorly. Fore wing light ochreous speckled with brown scales which are especially dense in basal fascia; fringes light ochreous. Discal and plical spots not defined, discocellular spot small, greyish brown. Hind wing whitish with a slight grey tint, base of fringes tinted ochreous. Legs light ochre to whitish, fore leg and mid tibia dull brown above.

♀ (Fig. 95). 15–16 mm. Coloration as ♂ but specimen from Tenerife has darker, more greyish fore wings and fore wing markings and more greyish hind wing. Discal and plical spots defined in two specimens but not visible in specimen from Algeria which is badly rubbed. Galea (visible only in Tenerife specimen) very short.

GENITALIA ♂. Saccus 0.98 mm long. Valva (Fig. 48) large, slender, with rounded apex. Dorsal margin of gnathos with slight medial convexity, angled dorsad at one-third and just below apex. Anellus spines (Fig. 34) large, arranged in elongate band three to four spines wide with proximal ten of about twenty well-defined spines heavily sclerotized. Aedeagus (Fig. 24) elongate, 1.86 mm long, without carinae. Vesica with two elongate, blade-shaped cornuti which are coarsely serrate below apex and which have minute thorn-like projections on lateral surfaces. At three-quarters length of aedeagus, vesica armed with three small, slender cornuti (Fig. 24 – inset). Aedeagus/saccus ratio 1.90.

GENITALIA ♀. Eighth sternite with shallow U- (Tenerife specimen) or V-shaped emargination with wall of ostium heavily sclerotized at base of emargination (Fig. 63). Posterior region of antrum swollen only slightly, transverse folds ill-defined. Longitudinal folds narrow, ill-defined, not transversely divided. Anterior region of antrum broad, parallel-sided. Wall of ductus bursae with well-defined annular sclerotization slightly anterior to end of antrum, appearing as dark stripes. Corpus bursae with three conspicuous needle-shaped signa (Fig. 54), each arising from one side of a short, blade-shaped base set in a large, circular, heavily sclerotized base-plate. In specimen from Yemen, sclerotization of signum base-plate uneven, giving it etched appearance and irregular margin.

REMARKS. *Tinea messalina* resembles *Tinea murariella* in its external appearance and cannot be reliably separated from it except by examination of the genitalia. In the male, the two large cornuti are similar to but larger than those of *murariella* which lacks the three small cornuti present in *messalina*. The small, thorn-like protuberances from the large cornuti are similar to those figured for *murariella* by Petersen (1959a) and Căpușe (1968) (see 'Remarks' for *murariella*). In the female, the antrum is larger and broader than in *murariella*. The uneven edges of the signum base-plates in the Yemeni specimen are reminiscent of those of *translucens* but are much more pronounced. The corpus bursae is missing from the specimen from Tenerife: this, coupled with the dissimilarly shaped antrum, leads me to exclude it from the paratype series. All the specimens here placed as *messalina* have previously been examined by Petersen who determined them as *murariella*. In Petersen's preparations of the two female paratypes, the genitalia have not been removed from the abdomen and it is impossible to discern the outline of the corpus bursae (Fig. 54).

BIOLOGY. Unknown. Specimens examined originate from the wetter parts of the Mediterranean region and from highland Yemen which has forested zones near San'a (the locality of collection of the specimen). Specimens were collected in January ('domestic' environment, Yemen) or May (all other specimens).

DISTRIBUTION. Canary Islands (Tenerife), Algeria, Italy, Yemen.

MATERIAL EXAMINED

4 ex. (1 ♂, 3 ♀ genitalia preparations).

Holotype ♂, Italy: Venice, Lido I., 29.v.1910 (*Walsingham*) (genitalia slide no. 8214 [Petersen prep. no. 1408]; BMNH).

Paratypes. Algeria: 1 ♀, Hammam-mes-Kontine, 2.v.1914 (*Rothschild & Jordan*) (genitalia slide no. 11076 [Petersen prep. no. 1719]; BMNH). Yemen: 1 ♀, San'a, within walls of Bir-el-Azab, caught in pavilion of the Crown Prince while we were waiting for an interview, 2400 m, i.1938 (*Scott & Britton*) (genitalia slide no. 7215 [Petersen prep. no. 1508]; BMNH).

Specimen excluded from paratype series. Canary Islands: 1 ♀, Tenerife, Pto Orotava, 2.v.1907 (*Walsingham*) (genitalia slide no. 11080 [remount of Petersen prep. no. 1561]; BMNH).

Tinea dubiella Stainton

(Figs 1, 2, 17, 41, 42, 47, 55, 62, 80, 96–99)

Tinea dubiella Stainton, 1859, *Entomologist's wkly Intell.* 6: 183. LECTOTYPE ♀, GREAT BRITAIN: Merseyside, Liverpool, 18.viii.1859 (*Gregson*) (genitalia slide no. 13389; BMNH), here designated [examined].

Tinea turicensis Müller-Rutz, 1920, *Mitt. Ent. Zürich* 5: 348, pl. 2, fig. 16. Lectotype ♂ (genitalia only), SWITZERLAND: Zürich (*Nägeli*) (genitalia slide no. M.28; NM, Basle), designated by Rasmussen, 1964: fig. 21 [examined]. **Syn. n.**

Tinea bispinella Zagulajev, 1960, *Fauna SSSR* 78: 169, figs 132–134. Holotype ♂, U.S.S.R.: Crimea, Sevastopol, 22.vi.1907 (*Pliginski*) (ZI, Leningrad) [examined]. **Syn. n.**

Tinea tenerifi Zagulajev, 1966, *Trudy zool. Inst. Leningr.* 37: 169, figs 22, 23. Holotype ♂, CANARY ISLANDS: Tenerife, Orotava, 24.iv.1895 (GAM, Bucharest) [examined]. **Syn. n.**

Tinea dubiella Stainton; Stainton, 1859c: 133; Wocke, 1861: 107 [catalogue]; Morris, 1870: 22, pl. 99, fig. 8 [description; figure; in birds' nests]; Wocke, 1871: 270 [catalogue]; Stainton, 1874: 3 [erroneously placed as a synonym of *pellionella*]; Merrin, 1875: 242 [synonym (?) of *pellionella*]; Hartmann, 1879: 199 [list]; Meyrick, 1895: 791 [synonym of *pellionella*]; Dyar, [1903]: 572 [synonym of *pellionella*]; Crombrugghe de Picquendaele, 1906: 124 [synonym of *pellionella*]; Corbet & Tams, 1943b: 111 [synonym of *pellionella*]; Petersen, 1957: 145 [synonym of *pellionella*]; Zagulajev, 1960: 149, 159 [synonym of both *pellionella* and *flavescentella*]; Căpușe, 1968: 319 [synonym of *pellionella*]; Petersen, 1969: 373 [synonym of *pellionella*]; Bradley *et alii*, 1972: 8 [synonym of *pellionella*].

Tinea turicensis Müller-Rutz; Müller-Rutz, 1922: 256 [Switzerland]; Müller-Rutz, 1932: 263 [erroneously placed as synonym of *pellionella*]; Petersen, 1957: 148, fig. 114 [♂ genitalia]; Petersen, 1960: 228 [Spain; ♀ genitalia]; Petersen, 1961c: 532 [Algeria; Morocco]; Wakely, 1962: 92 [Britain; breeding record]; Petersen 1963b: 414 [birds' nests; owl pellets]; Petersen, 1964b: 79 [status as 'household species']; Petersen, 1964d: 404, 417 [Spain]; Rasmussen, 1964: 337, pls 5–8, figs 17–29 [♂, ♀ genitalia; lectotype designated]; Gozmány & Szöcs, 1965: 143, figs 36B, 37B [key; genitalia figs]; Bradley, 1966a: 217 [synonymy amended]; Petersen, 1968: 98 [Germany]; Căpușe, 1968: 328, fig. 171 (*partim* – ♂ only) [♂ genitalia; Rumania]; Petersen 1969: 374, pl. fig. 25, figs 152, 161, 169 [♂, ♀ genitalia; biology; distribution]; Krogerus *et alii*, 1971: 28 [Sweden; Denmark]; Bradley *et alii*, 1972: 8 [checklist]; Petersen & Gaedike, 1975: 76 [Germany]; Kudrjajtseva, 1975: 619, figs 1, 2 [U.S.S.R. (Adzhar); ♂, ♀ genitalia; biology]; Hannemann, 1977: 222, pl. 14, fig. 5, figs 121a–b [genitalia; distribution].

Tinea bispinella Zagulajev; Kudrjajtseva, 1975: 622 [U.S.S.R.—Georgia].

[*Tinea pellionella* L.; Stainton, 1859d: 212 [Madeira]; Wollaston, 1879: 422 [St Helena]; Meyrick, 1893: 535 [Australia]; Rebel & Rogenhofer, 1894: 17, 88 [Canary Is]; Rebel, 1906: 44 [Canary Is]; Rebel, 1910: 366 [Madeira]; Rebel, 1917: 13, 25, 62 [Madeira, Canary Is, St Helena]. Misidentifications.]

[*Tinea metonella* Pierce & Metcalfe; Pierce & Metcalfe, 1934: 266 (*partim* – 1 ♂ only); Petersen, 1957: 148 and Rasmussen, 1964: 337 [*metonella* (based on Pierce slide 3208 – i.e. *dubiella*) erroneously placed as synonym of *turicensis*]. Misidentifications.]

[*Tinea flavescentella* Haworth; Bradley, 1953: 18 (*partim* – 1 ♂ only) [Ireland]; Căpușe, 1968: 331, figs 172B, 173B–C (*partim* – ♀ only) [♀ genitalia; Rumania]. Misidentification.]

♂ (Fig. 96). 9–12 mm. Head greyish ochre. Maxillary palpus light grey, reaching just beyond tip of second segment of labial palpus. Labial palpus dark grey, light grey on inner surface, tip paler. Galea extending to middle of second segment of labial palpus. Antenna dark brownish grey, reaching apex of fore wing. Thorax and tegula dull brownish grey, darker anteriorly. Fore wing dull brownish grey with a few

scattered yellowish scales, fringes concolorous; charcoal-grey scales at base of costa and in fold. Discal and plical spots charcoal-grey, elongate; discocellular spot darker, round. Hind wing grey, fringes brownish. Legs greyish ochre, fore leg and mid tibia blackish brown above.

♀ (Fig. 97). 11–15 mm. Coloration as ♂.

GENITALIA ♂. Saccus 0.78 ± 0.17 mm. Valva (Fig. 47) with costa slightly convex, apex rounded but more or less truncated at costal margin. Dorsal margin of gnathos evenly concave or almost straight in the middle; tip upturned towards uncus. Anellus spines (Figs 41, 42) flattened and overlapping, arranged in a tapered band up to four spines wide and containing about 20 spines; proximal spines large. Aedeagus (Fig. 17) 1.30 ± 0.26 mm long, without carinae. Vesica ornamented only with pair of small, short, divergent, peg-shaped cornuti just below apex of aedeagus. Aedeagus/saccus ratio 1.69 ± 0.29 .

GENITALIA ♀. Eighth sternite with broad, shallow V-shaped emargination (Fig. 62). Antrum markedly swollen posteriorly; transverse folds present and anterior to these a pair of conspicuous saucer-shaped lateral protuberances; anterior region of antrum short, slightly tapered anteriorly, longitudinal folds short, conspicuous, not transversely divided. Annular sclerotization at posterior end of ductus bursae ill-defined or absent. Corpus bursae (Fig. 55) with three or (usually) four small, thin, needle-like signa, each arising from minute unsclerotized tubercle.

REMARKS. *Tinea dubiella* is generally darker-coloured than any of the other species of the *pellionella*-group. Fresh and undamaged specimens in particular have darker and more greyish fore wings than other members of the *pellionella*-group and the hind wing is distinctly darker, being grey rather than ochreous-whitish or very pale grey as in the other species. In the male, the greatly reduced pair of peg-like cornuti (probably homologous with the large blade-shaped cornuti of other members of the *pellionella*-group) are characteristic: there are no carinae of any kind on the aedeagus. The female genitalia are remarkable for the curious development of the paired saucer-shaped protuberances of the postero-ventral wall of the antrum.

Four specimens of *dubiella* are known in which the coloration is aberrant. A specimen bred from a larva collected in Lincolnshire in 1976 is melanic (Fig. 99) and three female paralectotypes of *dubiella* are pale, bright yellow with much reduced fore wing markings (see Stainton, 1859a) (Fig. 98). The remaining three paralectotypes and lectotype of *dubiella* have normal coloration: both sexes are represented among the normal specimens of Stainton's series, not just males as he suggested (1859a).

This is the *Tinea turicensis* of authors following Petersen (1957) and has nothing to do with *Tinea metonella* Pierce & Metcalfe (see 'Remarks' for *translucens* – above). Before Petersen's examination of Müller-Rutz's specimens, *turicensis* had been ignored as Müller-Rutz himself (1932) came to consider it as 'only a form of *pellionella*' in exactly the same way as Stainton (1874) came to think that *dubiella* was 'only *pellionella*'. It is odd that the syntype-series of *dubiella* has not, until now, been closely examined. One specimen was dissected by Corbet in about 1941 (the slide is now apparently lost) but *dubiella* was considered by Corbet & Tams (1943b) to be a synonym of *pellionella*.

The Müller-Rutz collection (in NM, Basle) contains four moths (one with associated genitalia slide) and three slides of male genitalia (without associated moths) labelled as *turicensis*. Two of the moths, a male (without abdomen) and a female (genitalia slide no. 1745 [Petersen]/M.27), are type-specimens; the other two specimens, both undissected males, have no type-status. Two slides (M.28 and M.29) are labelled 'TYPUS'; M.29 may be from the above male type-specimen – there is a complete abdomen preserved on the slide and the whole of the abdomen has been removed from the specimen whereas in slides M.28 and M.30 only the seventh and eighth abdominal segments are preserved. The slides numbered M.28 and M.30 are not associated with specimens and M.30 has no type-status. Slide M.28 is the lectotype, designated by Rasmussen (1964), and I have labelled it as such. I have labelled the male and female type-specimens and slide M.29 as paralectotypes.

Several authors have misidentified specimens of *dubiella* as *pellionella* (see above), notably from Madeira, St Helena and the Canary Islands, localities from which *pellionella* is unknown. Căpușe (1968) illustrated the female genitalia of this species as *flavescentella*.

It is surprising that *dubiella* has been overlooked for so long. About half the '*pellionella*' in British collections examined have been found to be referable to *dubiella* and Rasmussen (1964) found the same proportion of misidentified specimens in Denmark. In F. N. Pierce's slide collection, four females of *dubiella* are segregated on slide no. 3223. Pierce's slide no. 3219 is of a male *dubiella* and is labelled '? *T. pellionella*'; his only other male is a syntype of *metonella*. His female *dubiella* (slide 3223) are labelled '*pellionella*' but he also had four other slides of genuine *pellionella*. It is evident that although Pierce recognized *dubiella* as different from *pellionella*, he did not pursue the investigation of its identity.

BIOLOGY. It is likely that *dubiella* is able to utilize much the same kinds of foodstuffs as *pellionella*. I have bred *dubiella* from damp carpet lining a disused dog-kennel; the carpet was also heavily infested with *Hofmannophila pseudospretella* (Stainton) (Oecophoridae). Petersen (1963b) has recorded *dubiella* (as *turicensis*) from swallows' nests and from pellets of barn owl. Wakely (1962) bred *dubiella* from an 'animal-skin rug' and found that the larvae also ate feathers. Specimens from T. B. Fletcher's collection (BMNH) are from stables or bred from birds' nests and specimens were bred from chicken feathers by Back (see 'Material examined'). Many of the specimens examined are labelled as having been collected in houses. I have found an adult and a pupa of *dubiella* on the walls of a bunk-room containing old feather pillows and horsehair mattresses. Two of Walsingham's specimens from Tenerife were collected as larvae or pupae on walls, a biotope reminiscent of that of *murariella* in Spain where the larvae probably feed on horsehair in plaster. Another of Walsingham's specimens is labelled 'ex marsh plant' but this must have been a pupation site.

The distribution of *dubiella* is remarkably wide, extending from Scandinavia south to St Helena and South Africa and eastward to Australia and New Zealand. Its distribution outside temperate western Europe and the Mediterranean region is sporadic, however, and *dubiella* must be considered as an introduction to Australasia and also to North America from where only four specimens are known. In Britain, *dubiella* has not been collected outdoors further north than Lincolnshire although little collecting of Tineidae has been done in the north of England or Scotland.

Little is known of the life-cycle of *dubiella*. Of 60 specimens examined from Britain, France and Germany, 31 were collected in July and the dates of collection range from May to September. Kudrjajtseva (1975) records adults of *dubiella* in the Caucasus from May to August. Of 18 specimens from the Canary Islands, Madeira, Spain, Morocco, Algeria and Sikkim, seven were collected in April, eight in May and single specimens in March, June and November. The November record (from Algeria) suggests that *dubiella* may be bivoltine in warmer latitudes where adults of the first generation fly about ten weeks earlier than in Britain. I have seen eight specimens from Australia and New Zealand, three collected in October, four in November, one in December and one in April, the last also possibly indicative of a second annual generation.

Wakely (1962) had, apparently, little difficulty in rearing *dubiella* but almost full-grown larvae, which I collected in Lincolnshire in July, proved difficult to rear. Placed on wool and fishmeal and kept at 20 °C, the larvae would not feed until the substrate was dampened (when the fish-meal began to decompose). The larvae moulted four times and only one adult was eventually reared, a melanic specimen (Fig. 99), which emerged in February the following year.

It is likely that *dubiella* has been extensively transported by man but the only definite record appears to be that of a female intercepted at Glasgow, in 1946 in a cargo of wool imported from New Zealand.

DISTRIBUTION. (Fig. 80.) Great Britain, Ireland, France, Germany, Switzerland, Spain, Madeira, Canary Islands, Morocco, Algeria, Sikkim, St Helena, South Africa, Australia, New Zealand, U.S.A. The following additional locality records from the literature are here accepted as reliable: Denmark (Rasmussen, 1964), Sweden (Krogerus *et alii*, 1971), Rumania (Căpușe, 1968), U.S.S.R. (Georgia, Adzhar) (Kudrjajtseva, 1975).

MATERIAL EXAMINED

106 ex. (40 ♂, 32 ♀ genitalia preparations); 4 larvae; 10 cases; 5 pupae.

Great Britain: 3 ex., Cornwall, Redruth, 31.vii.1955, 19, 24.vi.1956 (*Tremewan*); 1 ♂, Dorset, Corfe, 15.vii.1890 (*Bankes*); 1 ♂, Dorset, Kingston, 29.vii.1887 (*Bankes*); 1 ♂, Isle of Wight, Niton, 7.vii.1930 (*Fletcher*); 3 ex., Hampshire, Southampton, 17.vii.1925, 29.vii, 9.viii.1935 (*Fassnidge*); 2 ♂, Surrey, Redhill, in house, 6.vii.1935 (*Rait-Smith*); 2 ♂, 3 ♀, Sussex, Midhurst, various dates 1961–1963 (*Wakely*); 2 ♂, Kent, Sandwich Bay, in bird observatory bunk-room, 8–10.vii.1977 (*Robinson*); 2 ex., Greater London, Bromley, 27.vi.1943 (*Jacobs*); 2 ex., Greater London, Lewisham, in house, 24.vi.1876, 30.v.1882 (*Stainton*); 1 ♀, Essex, Hadleigh, 27.viii.1915 (*Whittle*); 2 ♂, Wiltshire, Marlborough, 10.vii.1922, 1.ix.1930 (*Meyrick*, *Fletcher*); 13 ex., Gloucestershire, Stroud, Rodborough Fort [Fletcher's house], in house and from birds' nests, various dates 1933–1934 (*Fletcher*); 10 ex., Norfolk, Merton, various dates 1889–1909 (*Durrant*); 1 ♂, Lincolnshire, Woodhall Spa, bred from damp carpet in disused dog-kennel, em. ii.1977 (*H. S. & G. S. Robinson*); 2 ♂, 4 ♀, Merseyside, Liverpool, 1859 (*Gregson*) (paralectotypes of *dubiella*); 1 ♀ (genitalia slide only), Strathclyde region, Glasgow, ex wool from New Zealand on SS *Empire Strength*, 9.ii.1946 (*Ministry of Agriculture, Fisheries & Food*). **Ireland:** 1 ♂, Co. Cork, Bantry, 4–15.vi.1952 (*Bradley*). **France:** 3 ex., Basses Pyrénées, St Pierre d'Irube, 25.vi.1936, 21, 27.v.1937 (*Adkin*); 1 ♀, Basses Pyrénées, St Jean de Luz, 13.vi.1950 (*Adkin*); 1 ♂, Cabrerets, 3–10.vii.1949 (*Jacobs*); 1 ♂, Cote d'Azur, St Aygulph, ex marsh plant [sic], 8.vii.1901 (*Walsingham*). **Germany (West):** 2 ♂, 5 ♀ (of 3 ♀, genitalia slides only), Schleswig-Holstein, Flensburg, various dates 1957–1958 (*Sattler*); 1 ♂, 1 ♀, Dortmund, 11, 13.vii.1933 (*Grabe*). **Switzerland:** 1 ♂, 1 ♀, Zürich, 28.vi, 11.vii.1918 (genitalia slide nos M.29 [Müller-Rutz], Pet. 1745 [Petersen]; NM, Basle) (paralectotypes of *uricensis*); 1 ♂ (genitalia slide only), Zürich (genitalia slide no. M.30 [Müller-Rutz]; NM, Basle) (no type status); 2 ♂, Zürich, ex larva, 2, 10.vi.1924 (*Müller-Rutz*) (NM, Basle) (no type status). **Spain:** 1 ♂, Granada, 14.vi.1901 (*Walsingham*). **Madeira:** 2 ♂, 1858 (*Wollaston*) (one ex Bethune-Baker coll.); 1 ♂, Machico, 23.iv.1904 (*Eaton*). **Canary Islands:** 1 ♂, 1 ♀, Tenerife, Guimar, on walls 27.iv, emerged 6.v.1907 (*Walsingham*); 1 ♂, Tenerife, Las Mercedes, 29.v.1907 (*Walsingham*); 1 ♂, Tenerife, iv.1885 (*Leech*). **Morocco:** 2 ex., Zig, 9.iv.1902 (*Walsingham*); 4 ex., Tangier, 14.iv, 4, 9.v.1902 (*Walsingham*); 1 ♂, Tangier, iii.1868 (*Blackmore*). **Algeria:** 2 ex., El Kantara, 22, 23.v.1903 (*Walsingham*); 1 ♂, Bône, 8.xi.1893 (*Eaton*). **Sikkim:** 1 ♂, 1 ♀, Kurseong, 1525 m, 26.iv.1922 (*Fletcher*). **St Helena:** 1 ♂ (*Wollaston*). **South Africa:** 1 ♀, Natal, Weenen, Estcourt, Kimbolton, 1892 (*Hutchinson*). **Australia:** 1 ♀, Parramatta, iv.1879 (*Raynor*); 1 ♀, Sydney, 3.xi.1884 (*Meyrick*); 1 ♀, Toowoong, 27.x.1898 (*Dodd*); 2 ex., Melbourne, xi.1888 (*Anderson*); 1 ♀, Port Lincoln, 5.xi.1882 (*Meyrick*); 1 ♂, Carnarvon, 22.x.1886 (*Meyrick*). **New Zealand:** 1 ♀, Nelson, 27.xii.1925 (*Philpott*) (MARC, Auckland). **U.S.A.:** 1 ♀, California, Los Angeles, Venice, viii.1918 (*P.*); 3 ♂, 1 ♀, Washington, D.C., ex feathers in chicken house, 26.v.1925 (*Back*) (NLMNH, Washington). **No Data:** 8 genitalia preparations by F. N. Pierce and A. S. Corbet.

Tinea steueri Petersen
(Figs 66, 69, 71, 72, 100)

Tinea steueri Petersen, 1966, *Ent. Nachr. Dresden* 10: 35, figs 2, 3. Holotype ♂, GERMANY (EAST): Thuringia, Bad Blankenburg, 20.vi.1965 (*Steuer*) (genitalia slide no. Pet. 2269 [Petersen]; coll. H. Steuer, Bad Blankenburg) [genitalia slide examined].

Tinea steueri Petersen; Petersen, 1969: 375, figs 156, 165 [redescription]; Petersen & Gaedike, 1975: 76, fig. 1 [♀ genitalia]; Hannemann, 1977: 220, pl. 17, fig. 6, figs 120a–b [♂, ♀ genitalia].

♂. 12 mm. Only genitalia slide examined. From Petersen's description, similarly patterned to ♀.

♀ (Fig. 100). 17 mm. Head ochreous with slight reddish tint. Maxillary palpus whitish, apparently long, extending well beyond tip of second segment of labial palpus [head preparation not made owing to lack of material]. Labial palpus greyish brown, blackish brown on outer surface. Antenna dull grey-brown, almost reaching apex of fore wing. Thorax and tegula dull grey-brown, darker anteriorly. Fore wing light greyish brown, flecked with dark grey-brown scales, base of costa and plical fold darker than remainder of wing; fringes light greyish brown. Discal and plical spots ill-defined, discocellular spot small, greyish brown. Basal quarter of costa swollen, with small, elongate, hyaline spot between *Sc* and *R*₁. Hyaline spot lacks scales on underside of wing and is covered above with thin, colourless scales. Hind wing very light grey, fringes paler. Legs light ochre, fore leg dark brown above.

GENITALIA ♂. Saccus short, 0.59 mm long. Valva (Fig. 71) triangular with apex evenly rounded, sacculus heavily sclerotized. Dorsal margin of gnathos slightly concave, tip not upturned; tip of uncus extended posteriorly and bent towards tip of gnathos. Anellus spines (Fig. 69) very large, arranged in elongate band of 11 spines edged with sclerotized plaques and with a few small thorn-like spines at distal end of band. Aedeagus 1.1 mm long [but this may be an underestimate – tip is broken], very broad, apparently without cornuti or carinae. Aedeagus/saccus ratio [possibly low – aedeagus damaged] 1.86.

GENITALIA ♀. Eighth sternite with deep, wedge-shaped emargination almost completely dividing sternite (Fig. 66). Antrum very broad, flattened and curved parallel with surface of eighth sternite; transverse

folds ill-defined. Anterior region of antrum represented only by short neck without longitudinal folds. Corpus bursae (Fig. 72) with four or five short, needle-like signa, each set in pyramidal base, posterior two signa set in very small sclerotized base-plates.

REMARKS. *Tinea steueri* is a large, dark species with a superficial resemblance to *pellionella* but it differs externally from all other members of the *pellionella*-group in having a narrow hyaline spot at the base of the fore wing costa. This zone is sometimes thinly scaled in the other species described here and, additionally, may be rubbed but in *steueri* the modification is conspicuous and the costa is convex around the spot. The greatly expanded antrum of the *steueri* female is characteristic. In the male, the anellus spines are very similar to those of *bothniella* and much larger than in the other members of the *pellionella*-group. The holotype of *steueri* is the only male known and in Petersen's dissection of the genitalia, the tip of the aedeagus has been broken off and pulled away with part of the vesica. The male genitalia of *steueri* are remarkably similar in practically all respects to those of *bothniella* but there is no trace of a cornutus in the remnants of the vesica of the holotype of *steueri*. The similarities include the peculiar form of the uncus and gnathos, the width of the aedeagus, the length of the saccus and the remarkable form of the anellus spines. The valva of *steueri* is, however, different from that of *bothniella*, being shorter and more triangular. The external appearance of the two species is quite different as is the structure of the female genitalia. There are similarities, too, between the male genitalia of *steueri* and *dubiella* but in the latter species the anellus spines are smaller and the tip of the uncus is not as strongly downturned towards the tip of the gnathos.

Petersen's (1966; 1969) and Hannemann's (1977) illustrations of the male genitalia of this species are inaccurate and figure the anellus spines as being part of the vesical ornamentation: their illustrations do not suggest that the aedeagus is damaged and this fact is not mentioned in their descriptions.

BIOLOGY. Unknown.

DISTRIBUTION. Germany, Hungary.

MATERIAL EXAMINED

2 ex. (1 ♂, 2 ♀ genitalia preparations), 0 larvae, 0 cases, 0 pupae.

Germany (East): 1 ♀, Thuringia, Bad Blankenburg, at light, 1.viii.1974 (*Steuer*). **Hungary:** 1 ♀, Bihar, Bischofsbad, 22.v.1913.

Tinea bothniella Svensson

(Figs 1, 67, 68, 70, 73–75, 81, 101)

Tinea bothniella Svensson, 1953, *Opusc. ent.* 18: 225, figs 1A–1F. Holotype ♂, SWEDEN: Västerbotten, Vännäs, Hällfors, 22.vii.1950 (*Svensson*) (colln I. Svensson, Kristianstad) [examined].

Tinea unidentella Zagulajev, 1960, *Fauna SSSR* 78: 168, figs 130, 131. 2 ♂ syntypes, U.S.S.R.: 1 ♂, nr Orsk, Guberlya, 1.vi.1891 (*Christoph*); 1 ♂, Irkutsk, Gryozhnukha, 24.vii.1934 (*Florov*). 1 ♂ syntype, MONGOLIA: Ulan Bator, 23–26.vi.1905 (*Kozlov*) (ZI, Leningrad) [examined]. [Synonymized by Petersen (1973b: 91).]

Tinea sibiricella Zagulajev, 1960, *Fauna SSSR* 78: 171, figs 3G, 135. 6 ♀ syntypes, U.S.S.R.: 1 ♀, nr Orsk, Guberlya; 1 ♀, Siberia, Minussinsk, 22.vi.1924 (*Filipjev*); 1 ♀, Yeniseyskiy Prov., Bunbui, 4.vi.1915 (*Valdaev*); 3 ♀, Karagandinskaya, Zhan-Arc Station, vii.1958 (*Zagulajev*) (ZI, Leningrad) [examined]. [Synonymized by Krogerus *et alii* (1971: 28).]

Tinea bothniella Svensson; Krogerus *et alii*, 1971: 28 [checklist; *sibiricella* synonymized; Sweden]; Petersen, 1973b: 91 [*unidentella* and *sibiricella* synonymized; Mongolia].

Tinea unidentella Zagulajev; Petersen, 1961c: 532, fig. 2 [♂ genitalia; U.S.S.R. – Volgograd].

♂ (Fig. 101). 10–15 mm. Head reddish ochre. Maxillary palpus whitish, elongate, as long as or longer than labial palpus. Labial palpus light greyish ochre, whitish on inner surface. Antenna three-quarters length of fore wing, light greyish ochre, basal segments darker. Thorax and tegula light greyish ochre, not noticeably darker anteriorly. Fore wing light greyish ochre, fringes slightly paler; discal, plical and discocellular spots absent. Hind wing pale brownish cream, darker at margins, fringes slightly paler. Legs pale

grey-brown, fore leg with only slightly darker scaling on upper surface. Abdomen light greyish ochre, paler ventrally.

♀. 14–18 mm. Coloration as ♂.

GENITALIA ♂. Saccus 0.69 ± 0.12 mm long. Valva (Fig. 70) elongate, apex rounded, not truncated, costa concave, sacculus heavily sclerotized. Dorsal margin of gnathos straight or slightly convex, tip not upturned towards uncus; tip of uncus extended posteriorly and bent towards tip of gnathos. Anellus spines (Fig. 68) very large, arranged in elongate band of 11 or 12 spines edged with and continued at distal end as sclerotized plaques. Aedeagus 1.30 ± 0.24 mm long, broad, without carinae; vesica with single large, elongate cornutus (Fig. 67) level with or protruding just beyond tip of aedeagus. Aedeagus/saccus ratio 1.88 ± 0.37 .

GENITALIA ♀. Eighth sternite with deep U-shaped emargination to beyond one-half (Figs 73, 74). Posterior region of antrum swollen, parallel-sided, flattened and curved parallel with surface of eighth sternite; transverse folds absent. Anterior region of antrum extremely short, with narrow longitudinal folds which have ill-defined transverse division at one-half separating unsclerotized anterior region of fold from heavily sclerotized posterior region. Middle of antrum with heavy annular sclerotization appearing as ill-defined transverse stripes; anterior to this, inner wall of antrum finely scobinate. Corpus bursae (Fig. 75) with six elongate, needle-shaped signa, each arising from unsclerotized pimple-like base.

REMARKS. *Tinea bothniella* is a large species lacking the characteristic three spots in the fore wing of the other species of the *pellionella*-group. The male genitalia are similar to those of *steueri* (see above); the single strong cornutus is characteristic although it is uncertain whether or not a similar cornutus is found in *steueri*. The valva of this species is larger and more rectangular than in *steueri* and the base of the gnathos is angled. In the female, there are more signa than in *steueri* and these are more elongate, do not arise from a sclerotized base-plate and are not nearly as conspicuous. The posterior region of the antrum is narrower, and the eighth sternite less deeply emarginated than in *steueri* which lacks longitudinal folds in the anterior wall of the antrum. The wing pattern is quite different from that of *steueri* which has three dark spots in the fore wing and a hyaline spot at the base of the costa: *bothniella* has a uniformly greyish ochre fore wing without a hyaline spot.

The original illustrations of the genitalia of *bothniella* given by Svensson (1953) are unsuitable for critical determination but those given subsequently by Petersen (1961c) and Zagulajev (1960) are satisfactory. Zagulajev (1960) figures the female genitalia still within the abdomen and his description mentions only two signa. It is very difficult to see any signa in *bothniella* without removing the genitalia from the abdomen and flushing the spermatophore out of the bursa copulatrix and it is possible that Zagulajev missed several signa.

Zagulajev was able to separate specimens of *unidentella* and *sibiriella* only by their venation and by the length of the maxillary palpi. He suggested in the original description of *sibiriella* (1960: 173) that they might be the opposite sexes of the same species. As his syntype-series of each included sympatric specimens (from Guberlya) it is surprising that he treated them as separate.

BIOLOGY. The only record of the biology of *bothniella* is given by Zagulajev (1960) who found larvae (determined as *sibiriella*) feeding in raptor pellets. It should be noted that throughout the 1975 translation of Zagulajev's (1960) work on the Tineinae, bird-pellets are erroneously translated as 'garbage' or 'refuse'. Zagulajev suggests that *bothniella* (as *sibiriella*) is confined to the steppe region, living in nests and pellets of birds, and has two or, under favourable conditions, three generations per year. His evidence for this is based on his having had adults emerge from raptor pellets in July and then in April the following year: larvae in the pellet hibernated during the winter. It is uncertain, however, whether the pellets were kept at normal Kazakhstan winter temperatures after collection or whether the April emergence was 'forced' in a temperature higher than normal.

Most of the adults of *bothniella* which I have examined were collected in July. Of seventeen specimens known to me (excluding Zagulajev's bred material), nine were collected in July, five in June and one in August: in addition, two specimens from Finland were collected in April. These April records do not support Zagulajev's contention that *bothniella* may be bivoltine; the habitat

of the specimens was artificially warm – they were from a population living in the museum of Turku University (Jalava – *pers. comm.*).

The distribution of *bothniella* suggests that it is the hardiest species of the *pellionella*-group: its localities all lie to the north of the 0 °C January isotherm and in its Siberian habitats the January mean temperature is in the range –6 to –18 °C.

DISTRIBUTION. (Fig. 81.) Sweden, Finland, U.S.S.R. (Volgograd). The following additional locality records from the literature are here accepted as reliable: U.S.S.R. (European region eastward to S. Siberia) (Zagulajev, 1960 – as *unidentella* and *sibiriella*), Mongolia (Zagulajev, 1960 – as *unidentella*).

MATERIAL EXAMINED

10 ex. (4 ♂, 4 ♀ genitalia preparations), 0 larvae, 0 cases, 0 pupae.

Sweden: 1 ♀, Luleå, 14.vii.1948 (*Svensson*) (genitalia slide no. 1001 [Robinson]; UZI, Lund) (paratype of *bothniella*); 1 ♂, Degerfors, Bøjern, 2.vii.1935 (*Dahlström*) (genitalia slide; UZI, Lund) (allotype of *bothniella*). **Finland:** 1 ♂, 1 ♀, Turku, 8.iv.1970 (*Linnaluoto*) (genitalia slide nos 666, 667 [Kyrki]; MZU, Oulu); 1 ♀, Sievi, 1974 (*Huhtala*) (genitalia slide no. 92 [Kyrki]; MZU, Oulu); 1 ♂, Puolanka (*Kiianlinna*) (genitalia slide no. 105 [Kyrki]; MZU, Oulu); 1 ♀, Kuusamo, 16.vii.1934 (*Löfqvist*) (ZMU, Helsinki); 2 ♀, Ruukki, 28, 30.vii.1924 (*Löfqvist*) (ZMU, Helsinki); 1 ♀, Rautalampi, 13.vii.1928 (*Klingstedt*) (ZMU, Helsinki). **U.S.S.R.:** 1 ♂, Volgograd, Krasnoarmeysk ('Sarepta'), vi.1861 or 24.vi.1864 [label refers to two specimens but there is now only one] (*Christoph*) (genitalia slide no. 8218 [Petersen]; BMNH).

Tinea hongorella Zagulajev

Tinea hongorella Zagulajev, 1975, *Insects Mongolia* 3: 338, figs 1–5. Holotype ♂, MONGOLIA: Bayan Khongorsk aimak, N. slope of Tsagan Bogdo-Ula, 1500 m, viii.1969 (*Gur'eva*) (ZI, Leningrad) [examined].

♂. [Description adapted from Zagulajev, 1975.] 10 mm. Head straw-yellow. Maxillary palpus yellowish grey, elongate, only slightly shorter than labial palpus. Galea not reaching tip of second segment of labial palpus. Antenna smooth, brownish grey. Fore wing yellowish grey dusted with ochre, glossy; discocellular spot ill-defined. Hind wing glossy, slightly broader and brighter than fore wing; fringes glossy, straw-yellow.

♀. Unknown.

GENITALIA ♂. [Description adapted from Zagulajev, 1975.] Saccus length unknown. Valva elongate, costa concave, apex evenly rounded and hardly truncated. Dorsal margin of gnathos angled dorsad at one-third, straight from one-third to four-fifths then slightly concave to apex. Anellus spines small, distributed in a band three or four spines wide. Aedeagus length unknown, comparatively long, with two bands of thorn-like carinae arising from rod-like sclerotizations either side of the apex; vesica without cornuti. Aedeagus/saccus ratio [from Zagulajev's fig. 3] 1.87.

REMARKS. This is a glossy, yellowish species with an ill-defined fore wing pattern. The pattern is not, however, obsolete as in *bothniella*. The structure of the aedeagus is characteristic, cornuti being absent and the lateral lines of carinae being quite unlike those of other members of the *pellionella*-group. The venation of the right fore wing of the holotype is remarkable in that a fourth medial branch (M_4) is present: Zagulajev does not state whether or not the specimen is symmetrical.

Tinea hongorella is only known from the holotype.

BIOLOGY. Unknown. The holotype was collected in August. Zagulajev suggests that, as in allied species, larvae of *hongorella* may feed on substances of animal origin in the nests of birds or rodents.

DISTRIBUTION. Mongolia.

MATERIAL EXAMINED

None.

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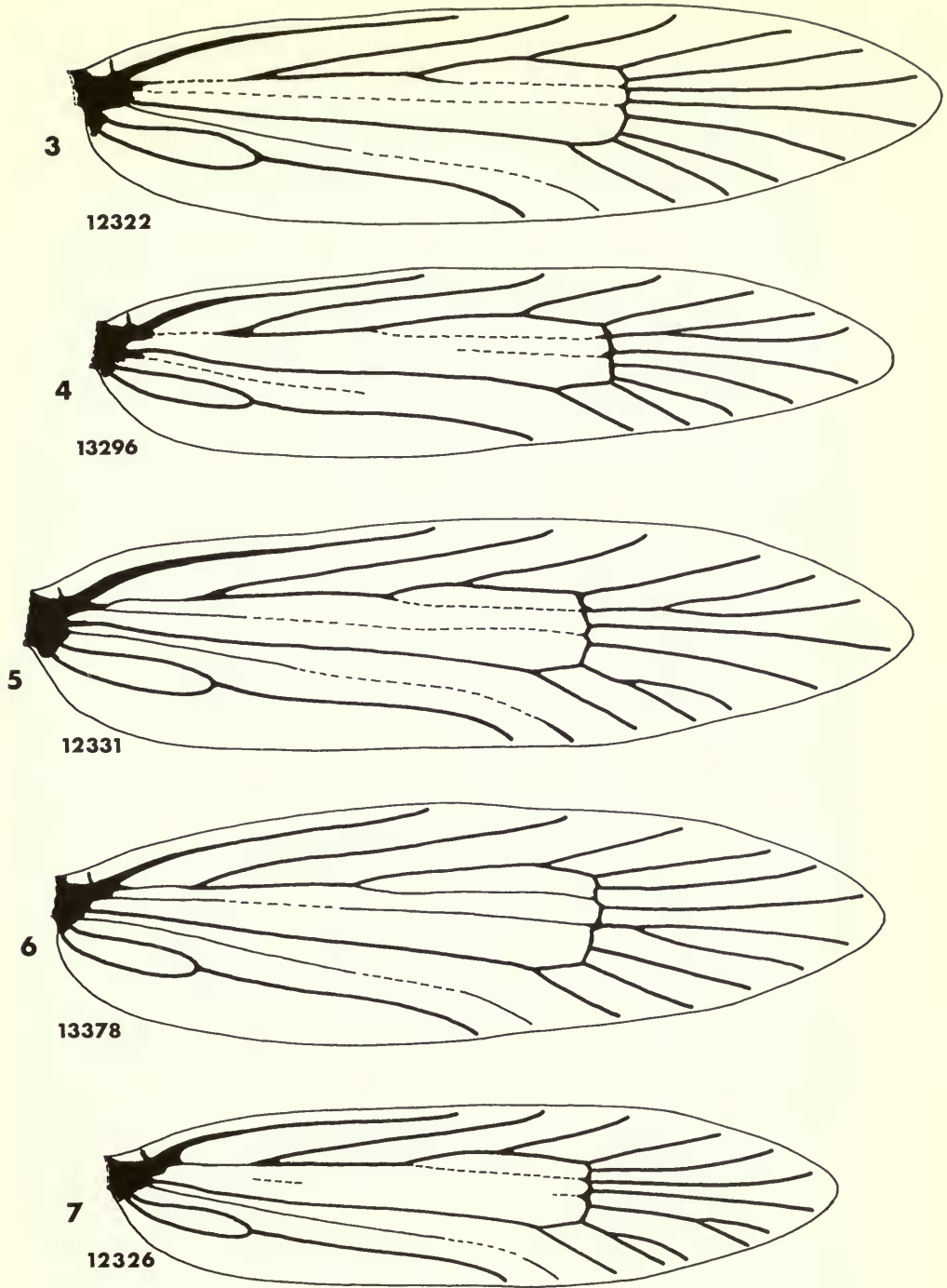
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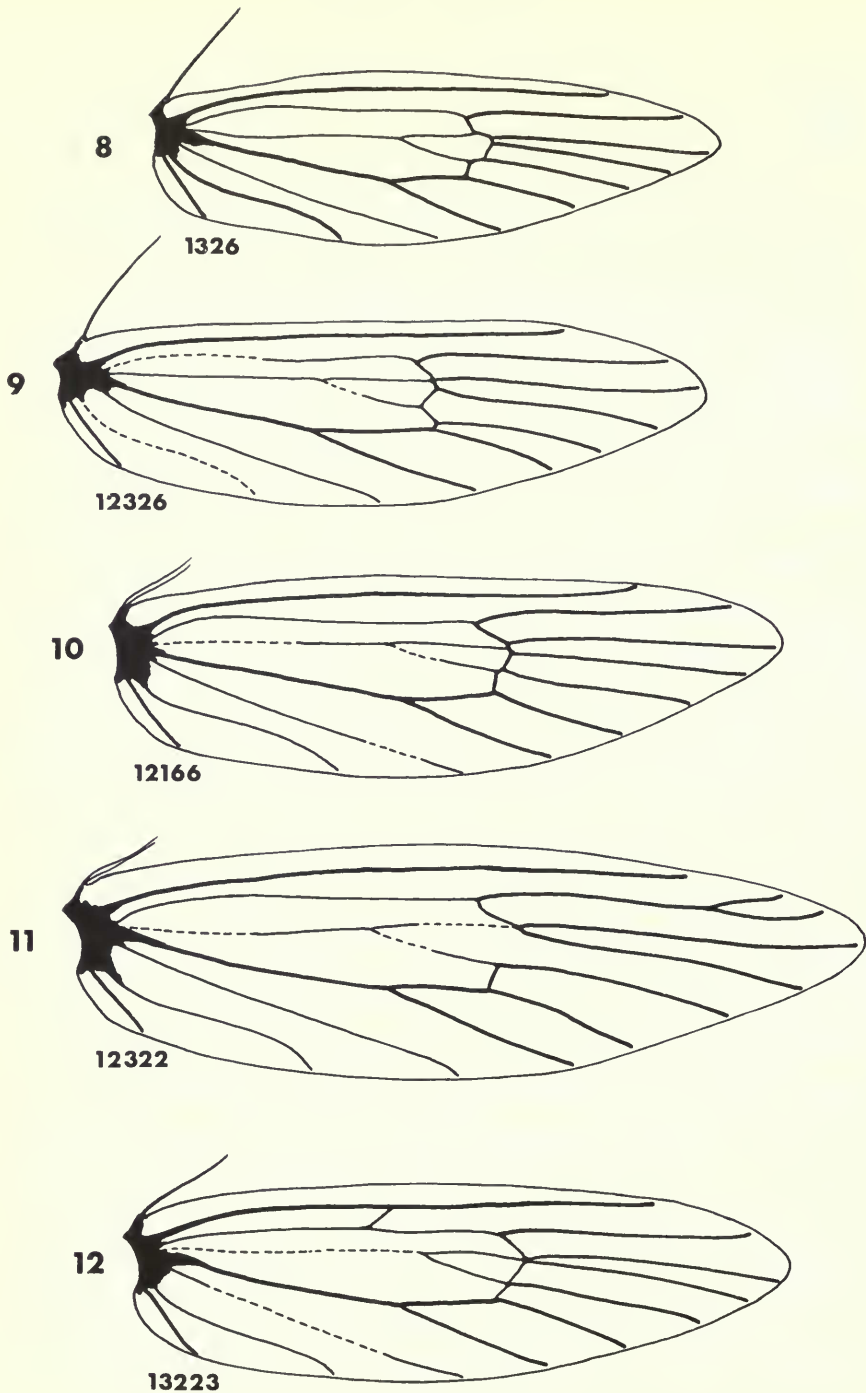
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Figs 3-7 Fore wing venation of *Tinea* species. 3, *translucens*, ♂, Britain; 4, *pellionella*, ♀, Britain; 5, *translucens*, ♀, Britain; 6, *flavescentella*, ♀, Britain; 7, *translucens*, ♂, Britain. Scale = 1 mm. Numbers = wing preparation numbers.



Figs 8–12 Hind wing venation of *Tinea* species. 8, *flavescentella*, ♂, Britain; 9, *translucens*, ♂, Britain; 10, *murariella*, ♀, France; 11, *translucens*, ♀, Britain; 12, *lanella*, ♂, Britain. Scale = 1 mm. Numbers = wing preparation numbers.

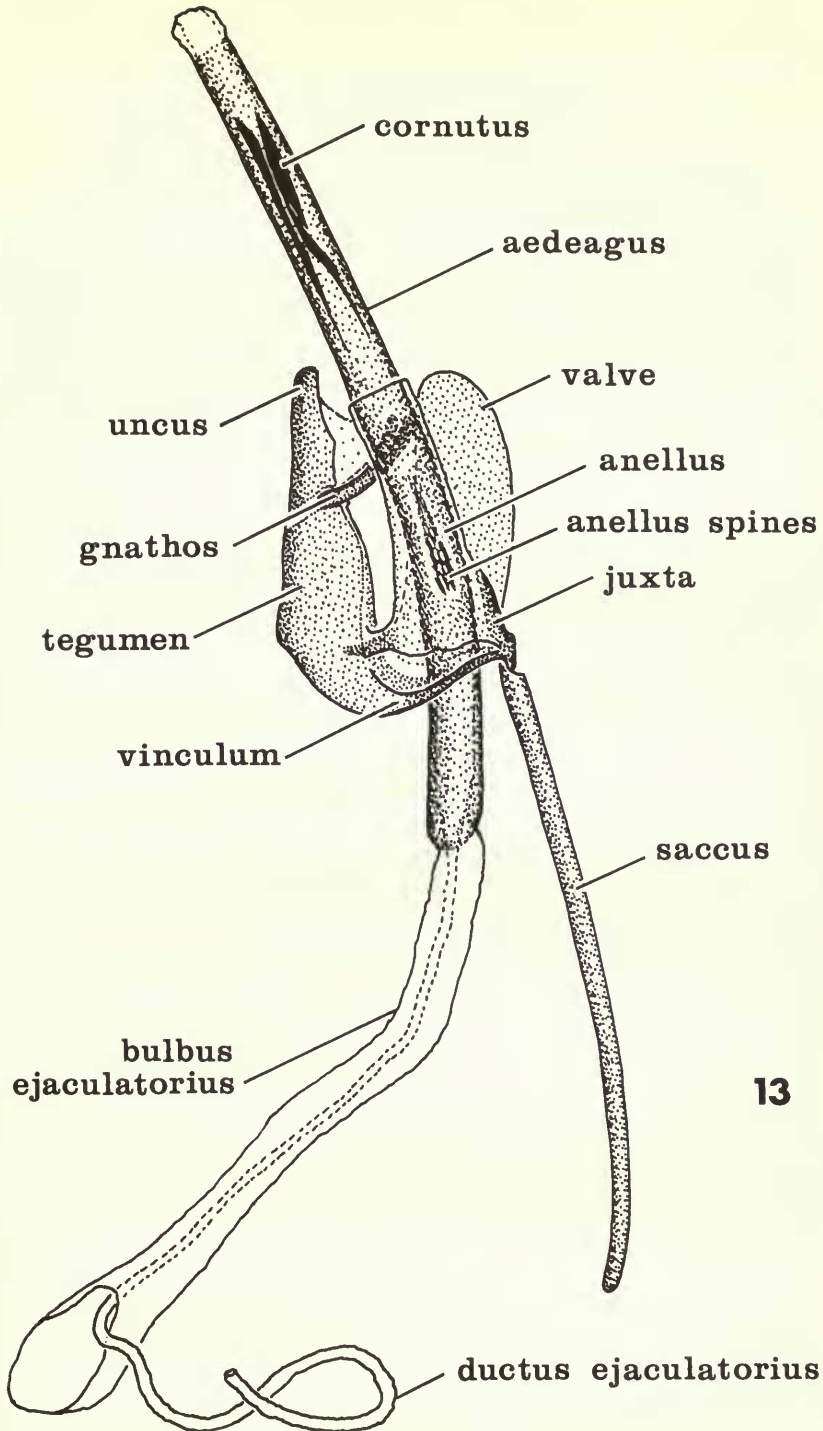
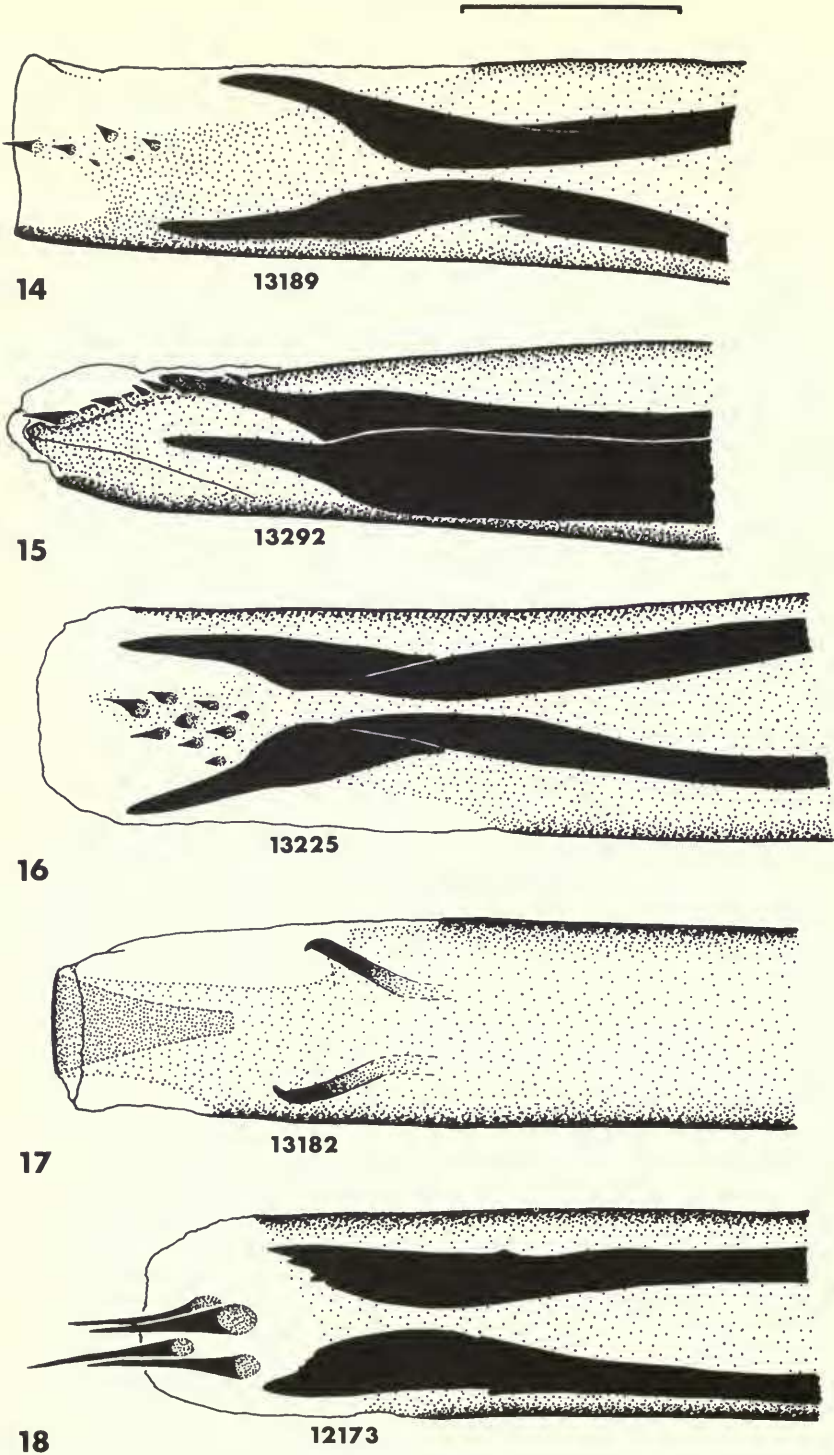
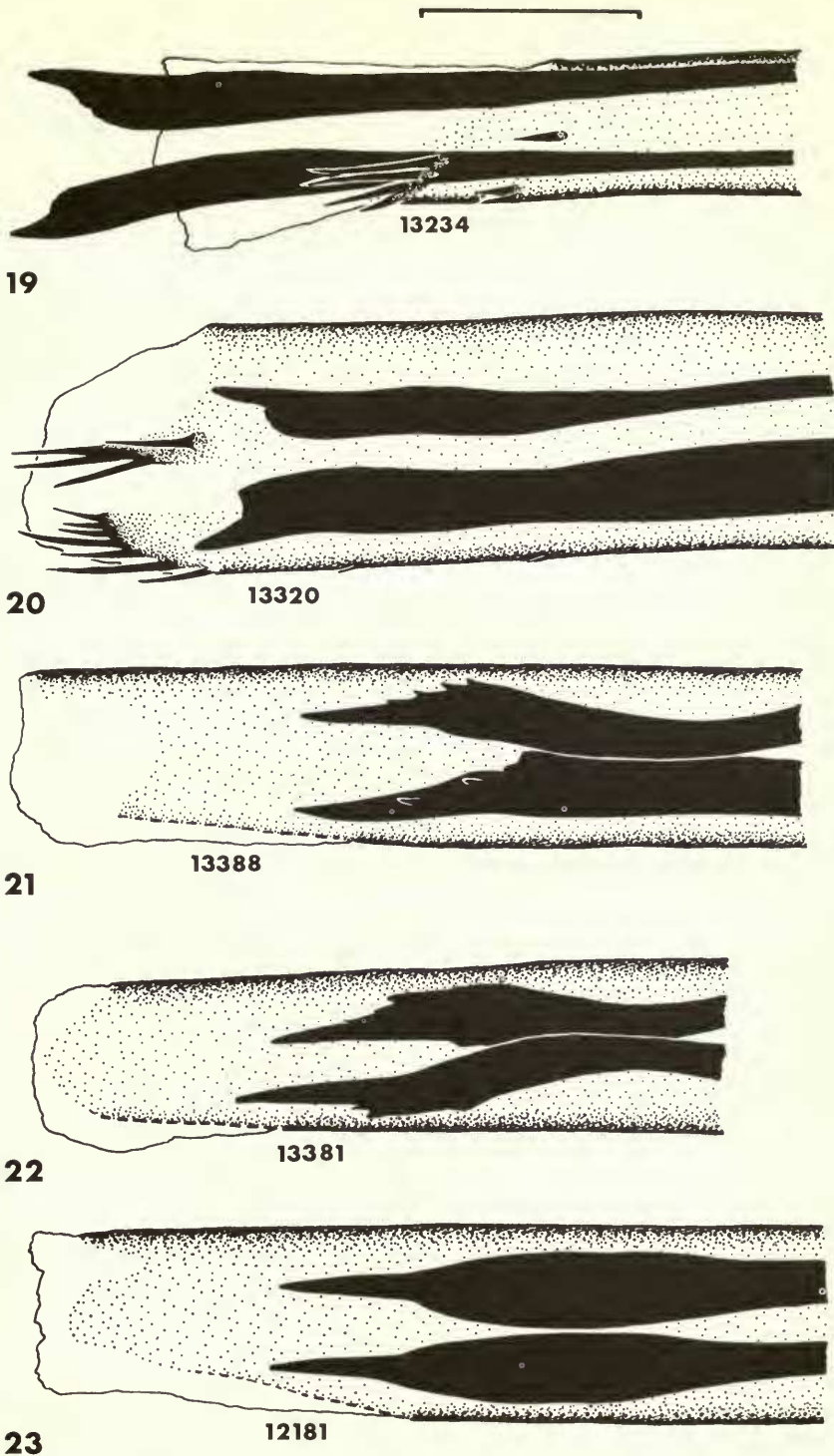


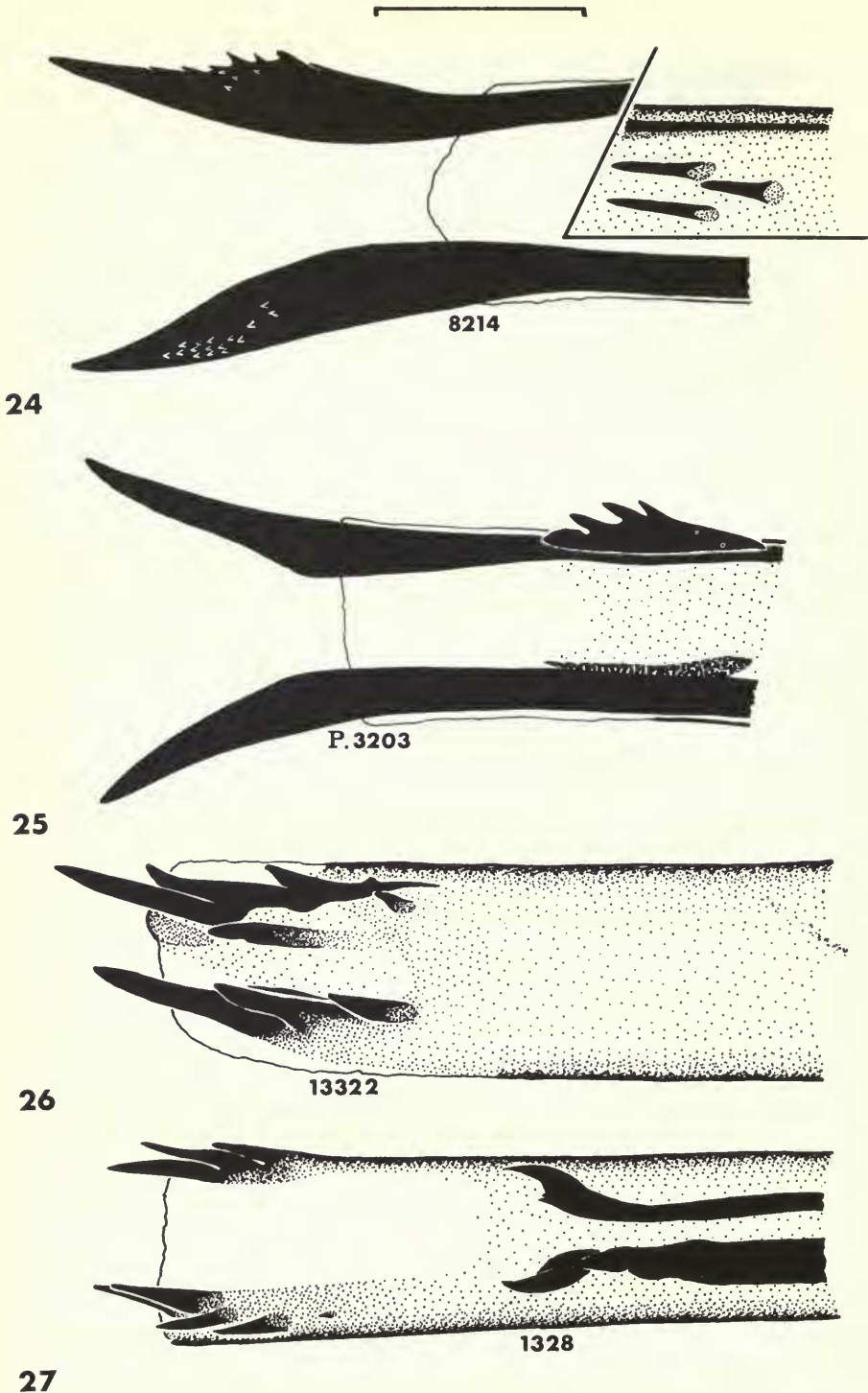
Fig. 13 Schematic diagram of ♂ genitalia of a species of the *Tinea pellionella* group.



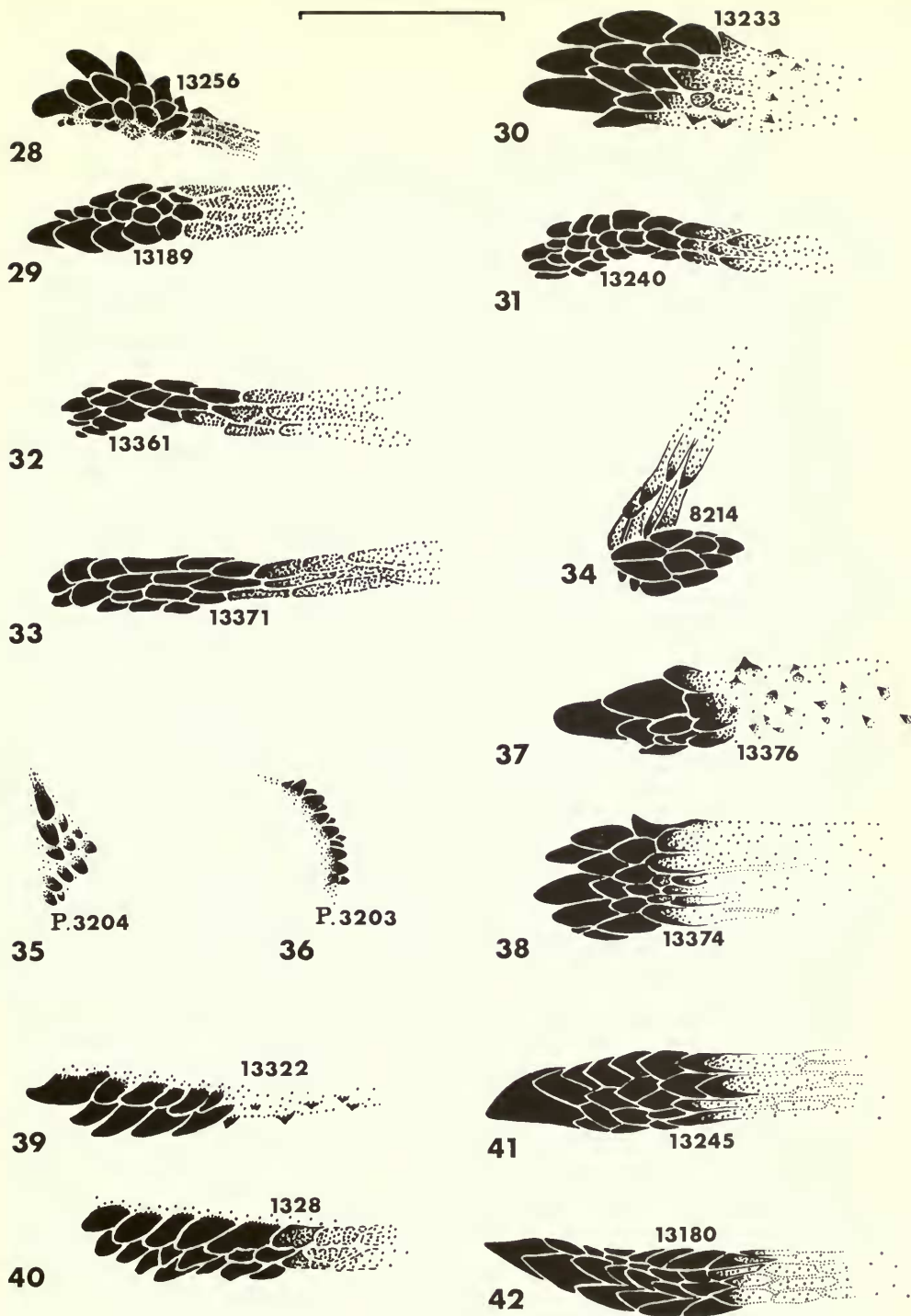
Figs 14–18 Tip of aedeagus of *Tinea* species. 14, *pellionella*, Britain; 15, *pellionella*, Britain; 16, *pellionella*, Germany; 17, *dubiella*, Madeira; 18, *translucens*, Britain. Scale = 1 mm. Numbers = genitalia slide numbers.



Figs 19–23 Tip of aedeagus of *Tinea* species. 19, *translucens*, Japan; 20, *translucens*, Japan; 21, *murariella*, Tenerife; 22, *murariella*, France; 23, *murariella*, France. Scale = 0.1 mm. Numbers = genitalia slide numbers.

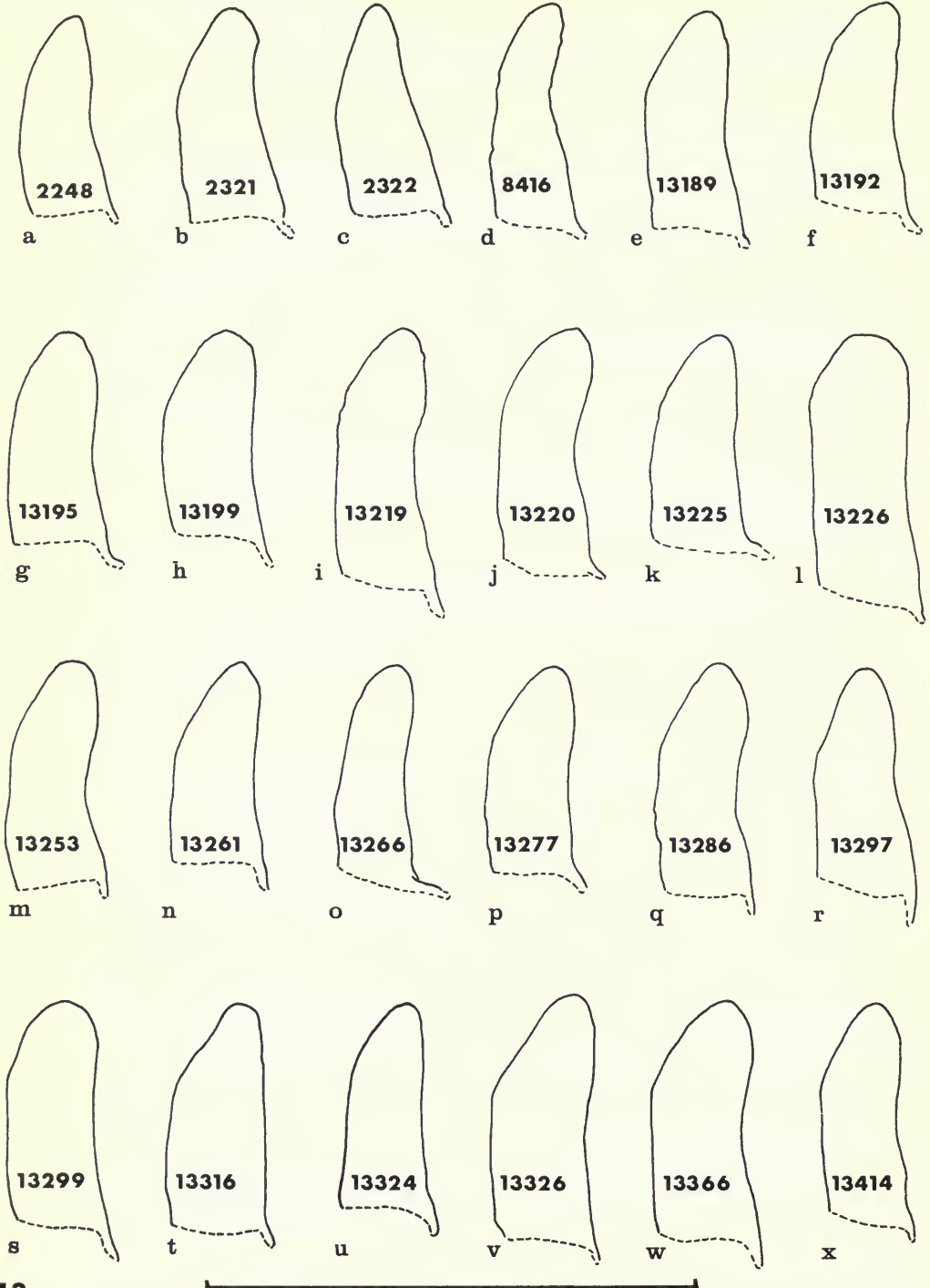


Figs 24–27 Tip of aedeagus of *Tinea* species. 24, *messalina*, holotype, Italy (cornuti inset); 25, *lanella*, paralectotype, Britain; 26, *flavescetella*, Britain; 27, *roesleri*, paratype, South West Africa. Scale = 0.1 mm. Numbers = genitalia slide numbers.



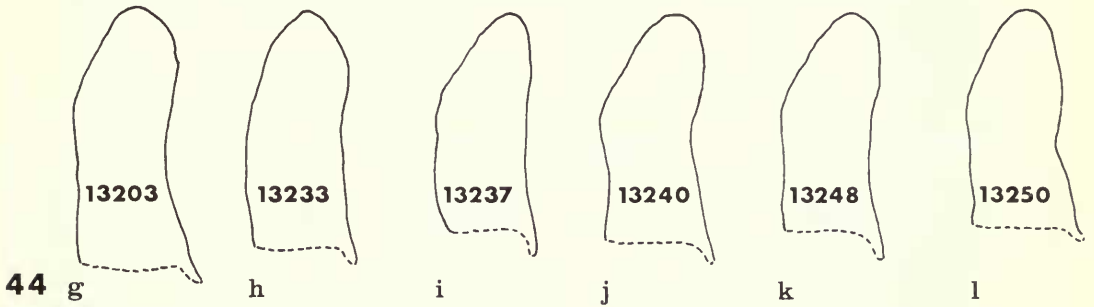
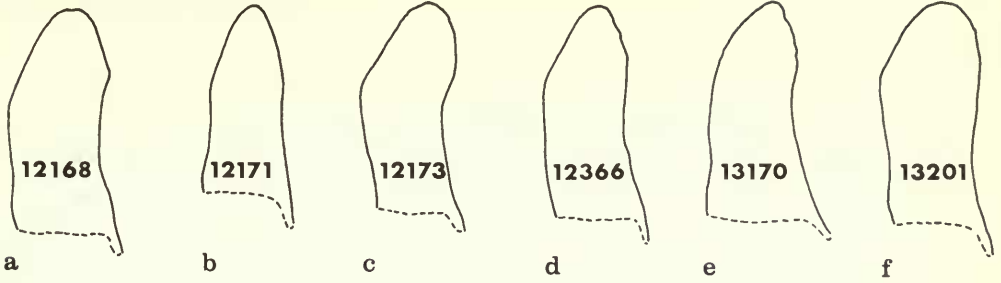
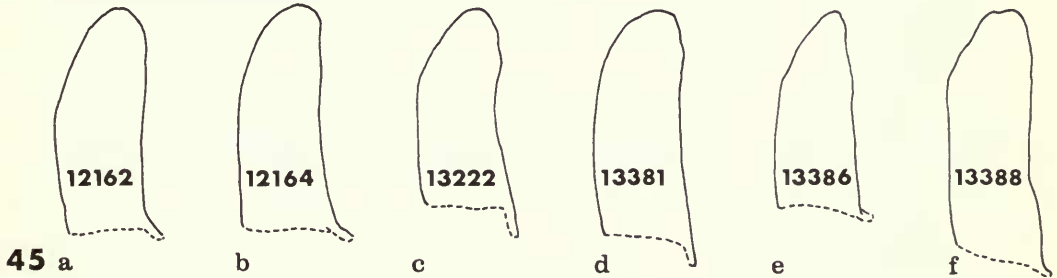
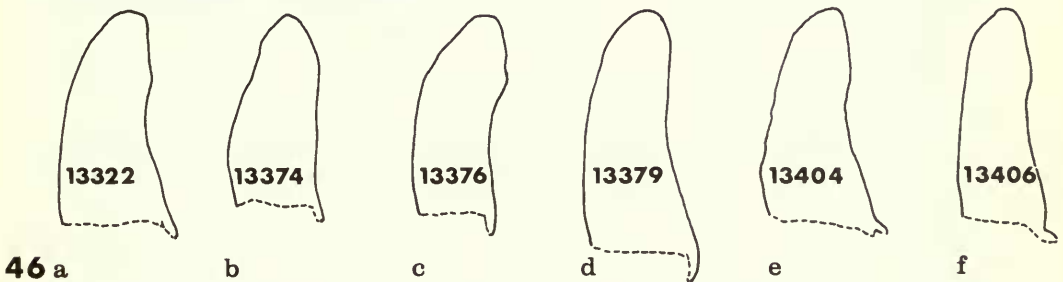
Figs 28–42 Anellus spines of *Tinea* species. 28, *pellionella*, Switzerland; 29, *pellionella*, Britain; 30, *flavescentella*, Spain; 31, *translucens*, India; 32, *murariella*, Portugal; 33, *murariella*, Algeria; 34, *messalina*, holotype, Italy; 35, *lanella*, lectotype, Britain; 36, *lanella*, paralectotype, Britain; 37, *flavescentella*, Britain; 38, *flavescentella*, Algeria; 39, *flavescentella*, Britain; 40, *roesleri*, South West Africa; 41, *dubiella*, Sikkim; 42, *dubiella*, Spain. Scale = 0.1 mm. Numbers = genitalia slide numbers.

pellionella

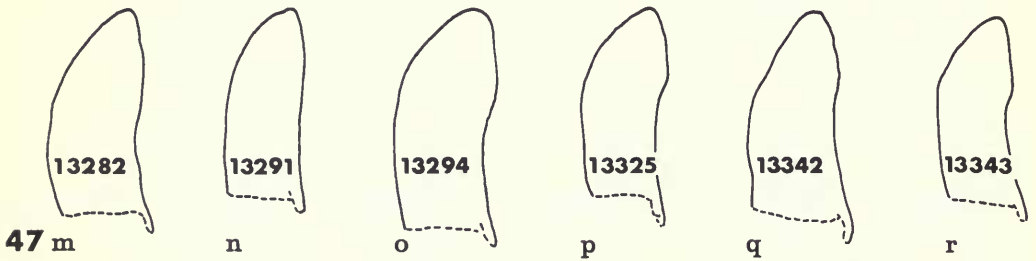
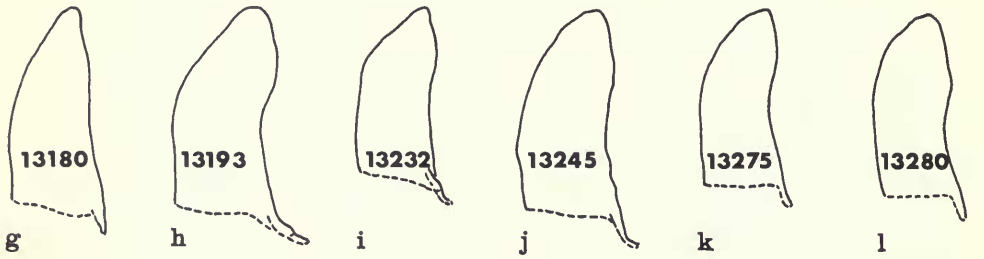
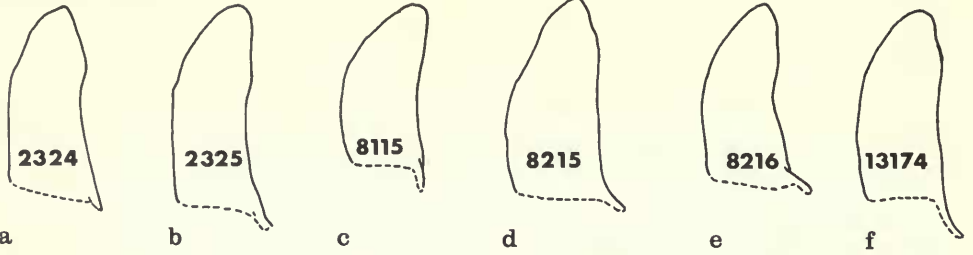
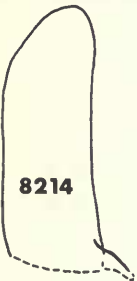


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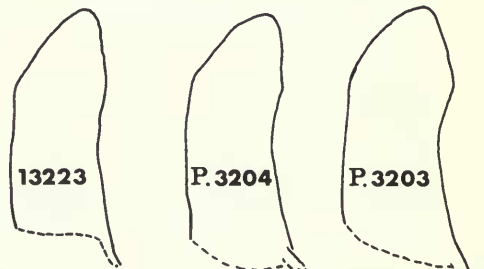
Fig. 43 Variation in outline of left valva in (a-x) 24 specimens of *Tinea pellionella*.
Scale = 1 mm. Numbers = genitalia slide numbers.

translucens**murariella****flavescentella**

Figs 44-46 Variation in outline of left valva in *Tinea* species. 44a-l, *translucens*; 45a-f, *murariella*; 46a-f, *flavescentella*. Scale = 1 mm. Numbers = genitalia slide numbers.

dubiella**messalina**

48

lanella

49 a

b

c

Figs 47, 49 Variation in outline of left valva of *Tinea* species. 47a-r, *dubiella*; 49a-c, *lanella*. Scale = 1 mm. Numbers = genitalia slide numbers.

Fig. 48 Outline of left valva of holotype of *Tinea messalina*, Italy. Scale = 1 mm. Number = genitalia slide number.

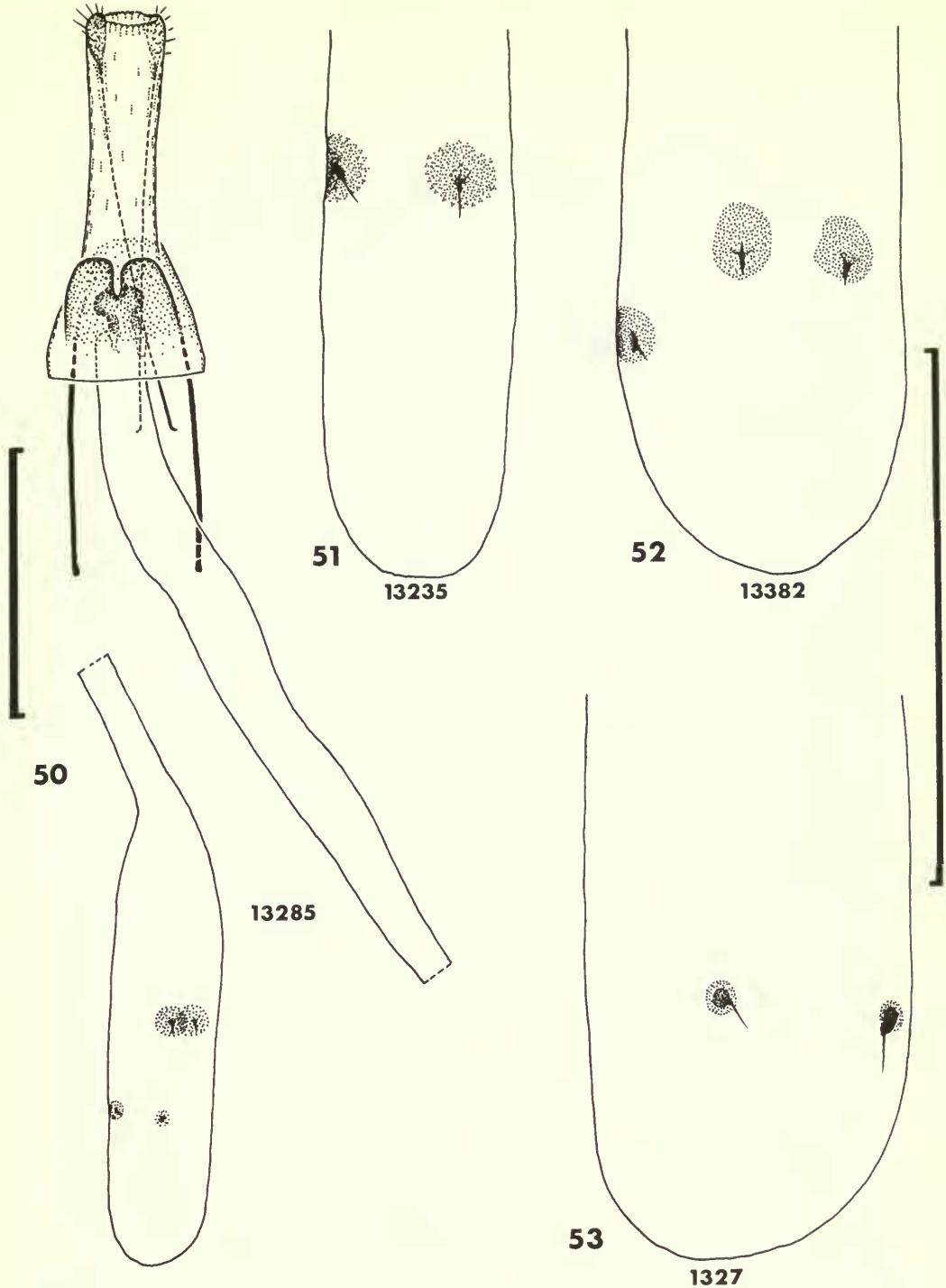
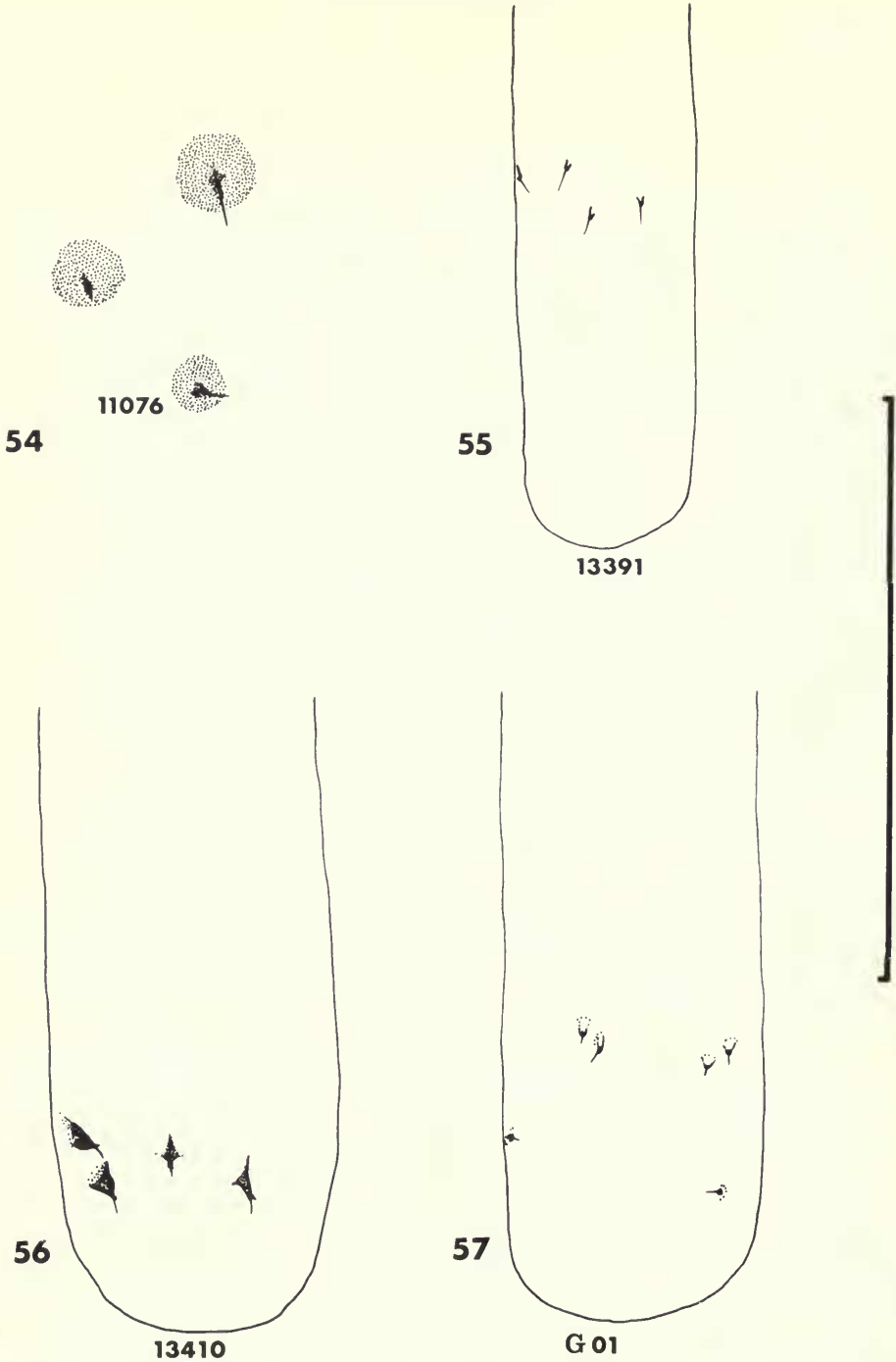


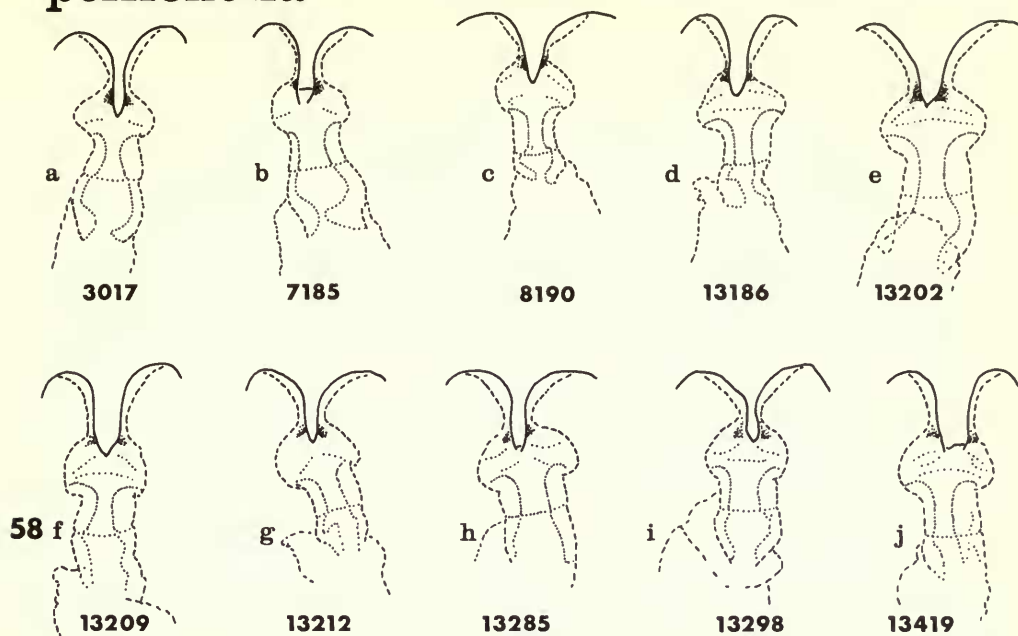
Fig. 50 Female genital armature of *Tinea pellionella*, Britain. Scale = 1 mm.

Figs 51-53 Anterior region of corpus bursae and signa of *Tinea* species. 51, *translucens*, India; 52, *murariella*, France; 53, *lanella*, paralectotype, Britain. Scale = 1 mm. Numbers = genitalia slide numbers.

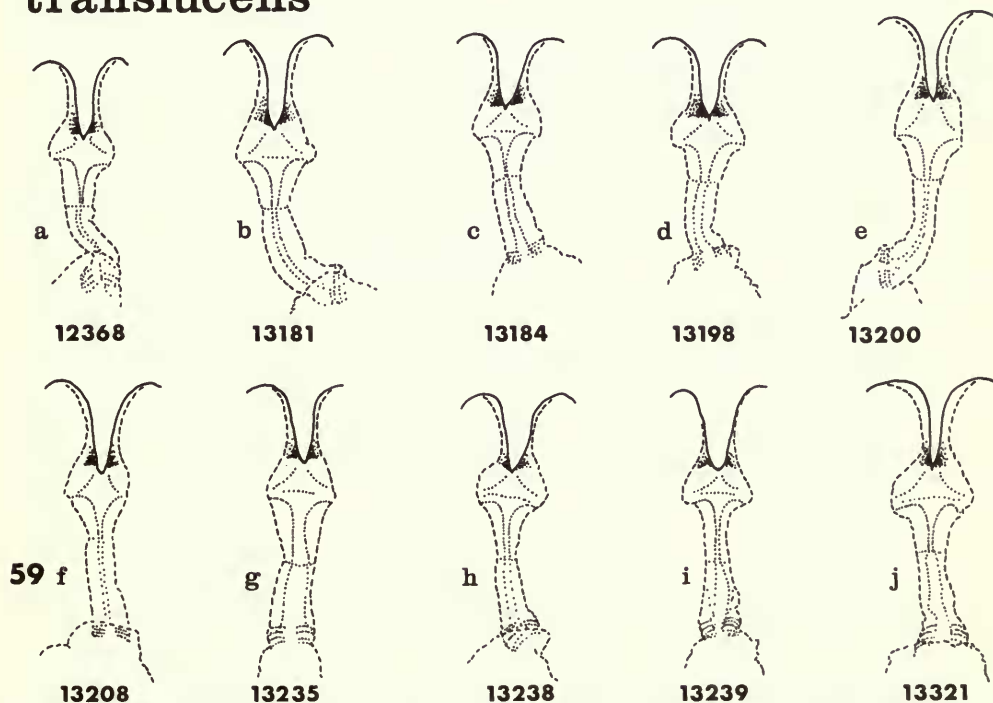


Figs 54–57 Anterior region of corpus bursae and signa of *Tinea* species. 54, *messalina*, paratype, Algeria (outline of corpus bursae not visible in preparation); 55, *dubiella*, Britain; 56, *flavescentella*, Britain; 57, *roesleri*, paratype, South West Africa. Scale = 1 mm. Numbers = genitalia slide numbers.

pellionella

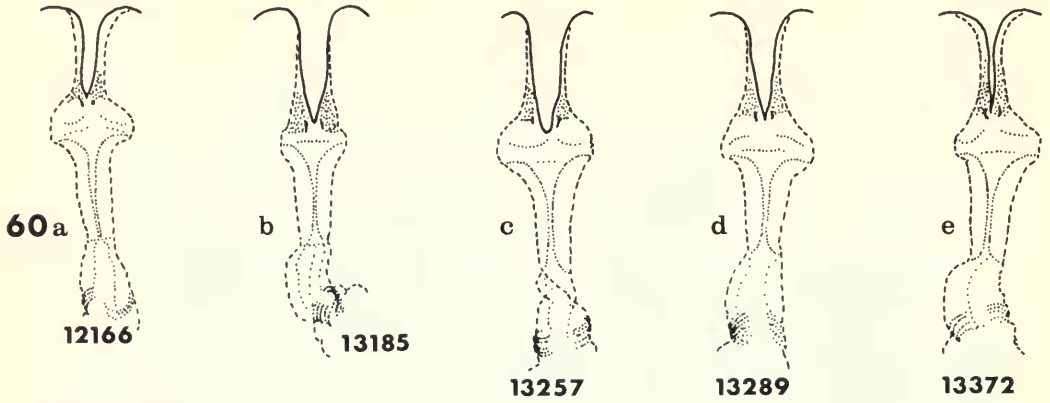


translucens

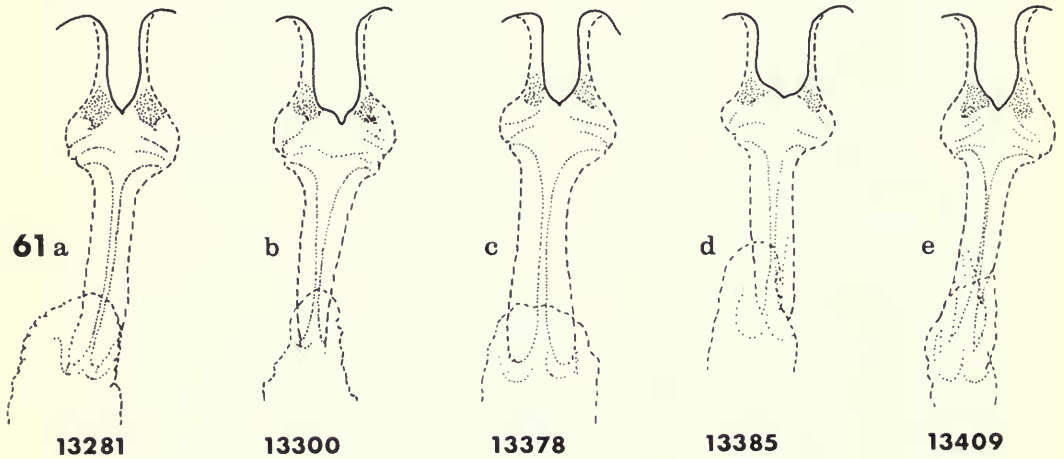


Figs 58-59 Outline of posterior margin of eighth sternite and antrum of *Tinea* species. 58a-j, *pellionella*; 59a-j, *translucens*. Scale = 1 mm. Numbers = genitalia slide numbers.

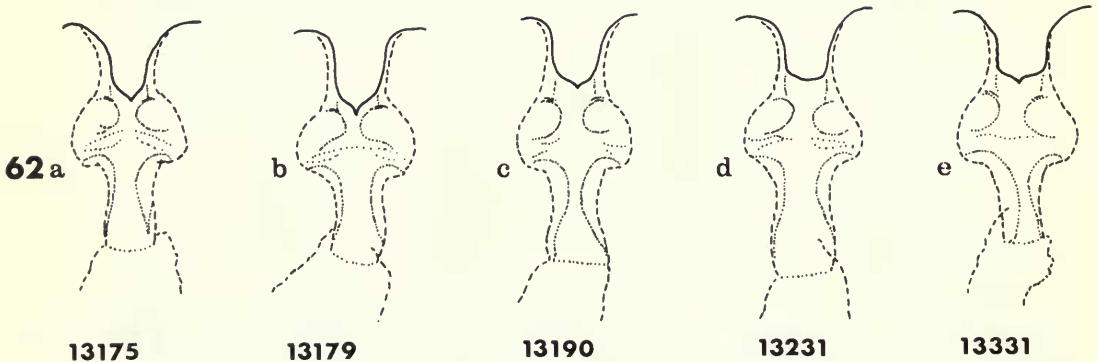
murariella



flavescentella

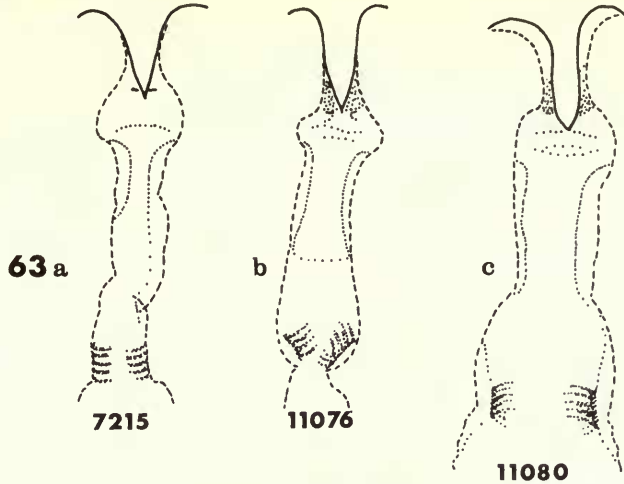


dubiella

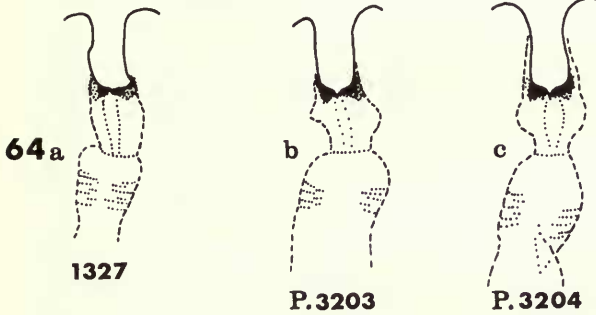


Figs 60–62 Outline of posterior margin of eighth sternite and antrum of *Tinea* species. 60a–e, *murariella*; 61a–e, *flavescentella*; 62a–e, *dubiella*. Scale = 1 mm. Numbers = genitalia slide numbers.

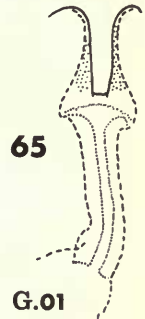
messalina



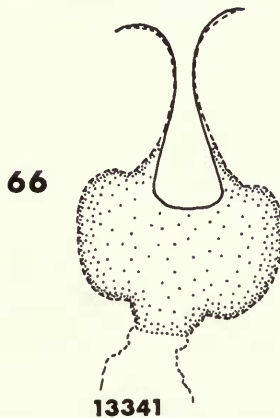
lanella



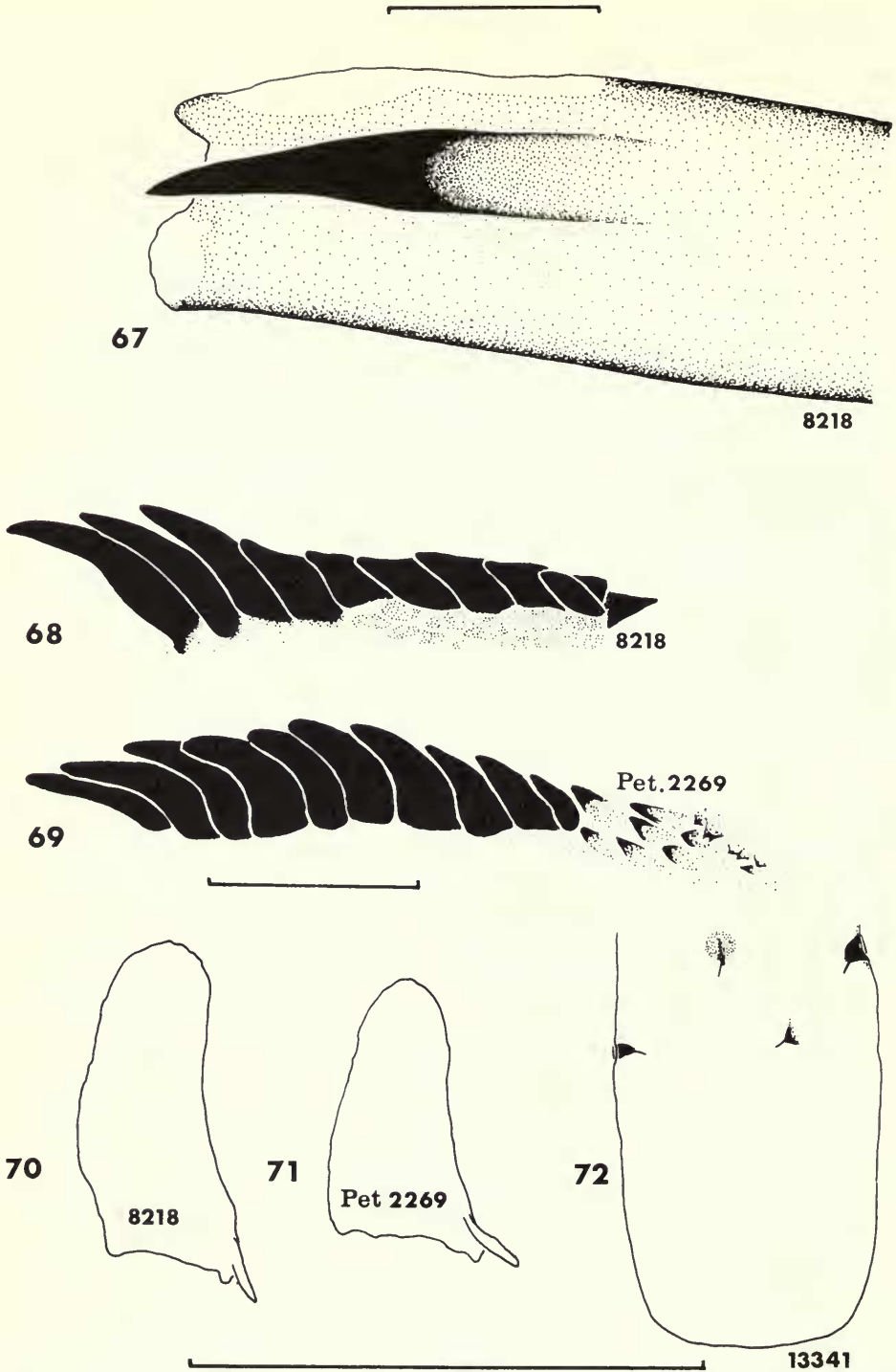
roesleri



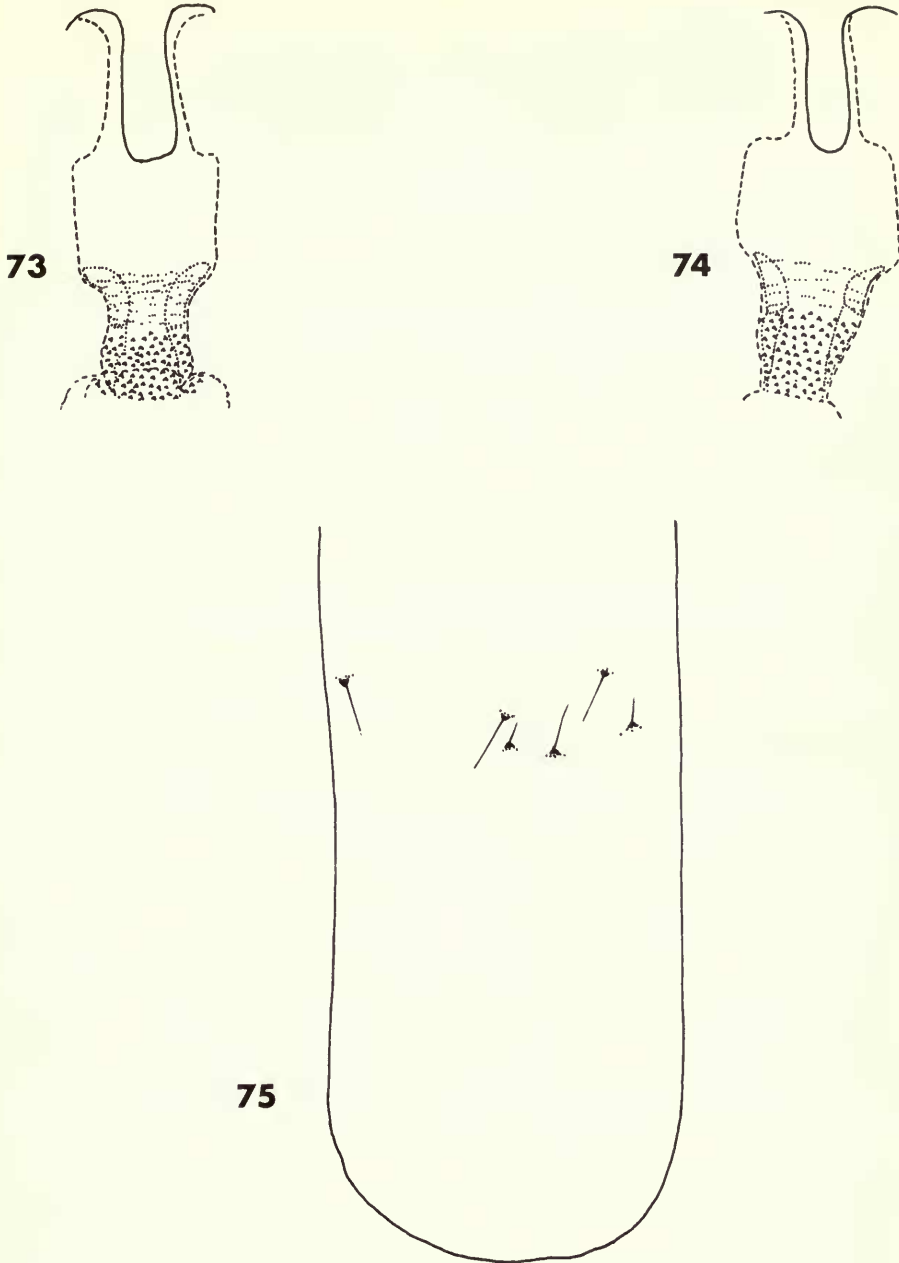
steueri



Figs 63–66 Outline of posterior margin of eighth sternite and antrum of *Tinea* species. 63a–c, *messalina*; 64a–c, *lanella*; 65, *roesleri*; 66, *steueri*. Scale = 1 mm. Numbers = genitalia slide numbers.



Figs 67-72 67, apex of aedeagus of *Tinea bothniella*, U.S.S.R. 68, anellus spines of *T. bothniella*, U.S.S.R. 69, anellus spines of *T. steueri*, holotype, Germany. 70, outline of left valve of *T. bothniella*, U.S.S.R. 71, outline of left valve of *T. steueri*, holotype, Germany. 72, anterior region of corpus bursae and signa of *T. steueri*, Hungary. Scale = 1 mm. Numbers = genitalia slide numbers.

bothniella

Figs 73–75 Female genitalia of *Tinea bothniella*. 73, 74, outline of posterior margin of eighth sternite and antrum. (73), paratype, Sweden; (74), holotype, Sweden. 75, anterior region of corpus bursae and signa of paratype, Sweden. Scale = 1 mm.

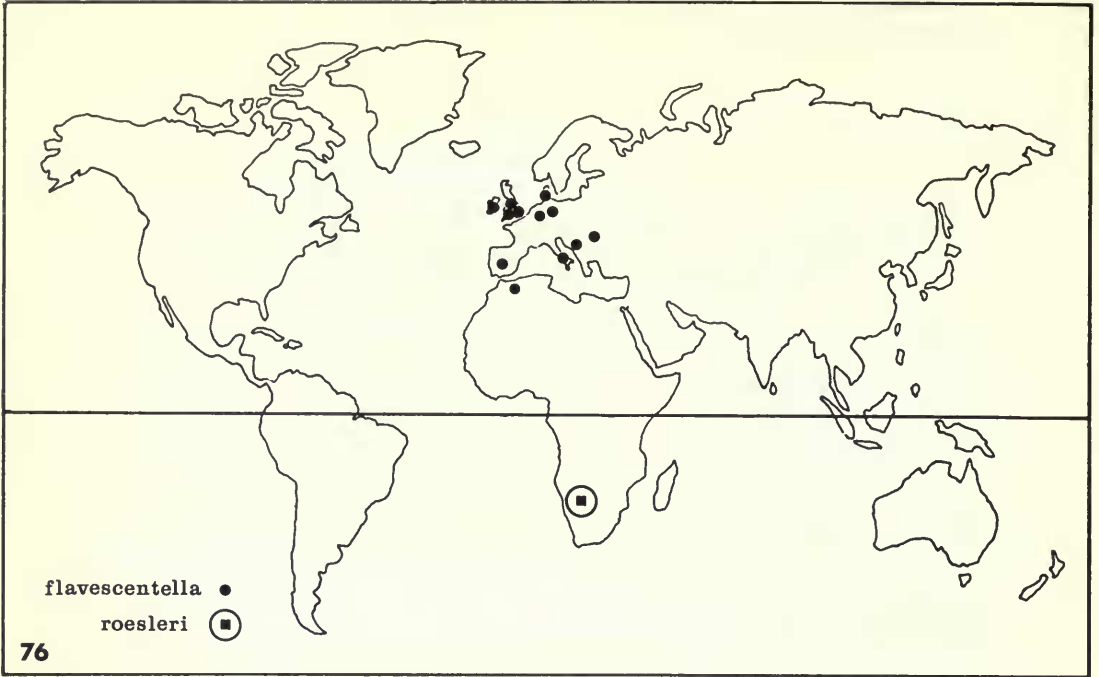


Fig. 76 Distribution map of *Tinea flavescentella* and *T. roesleri*.

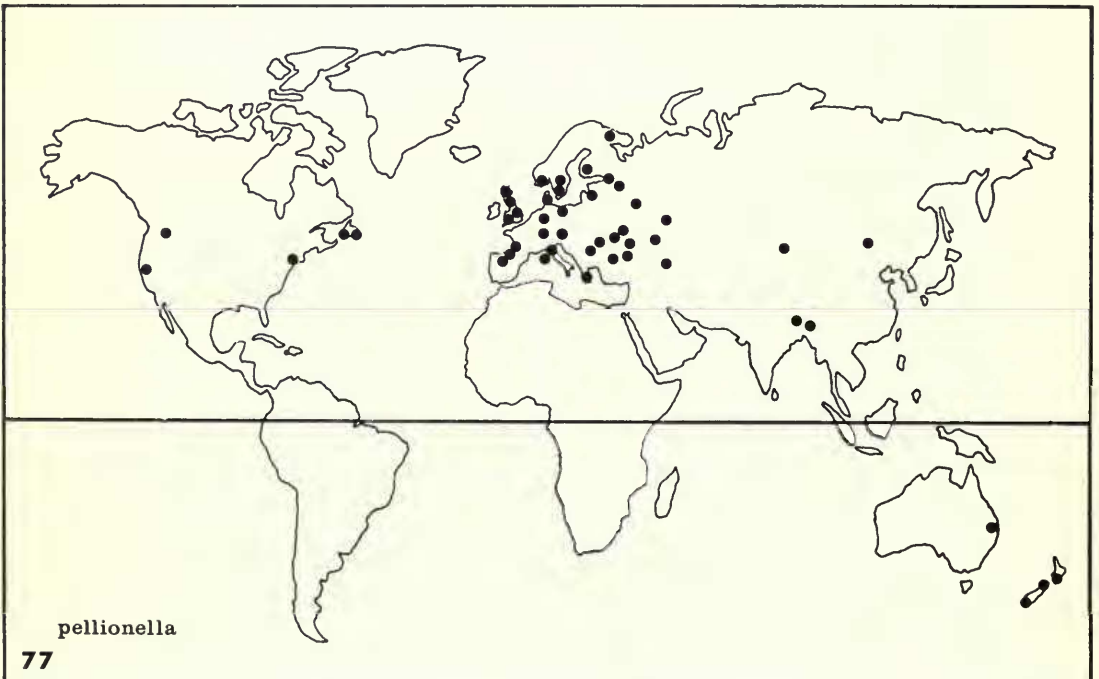


Fig. 77 Distribution map of *Tinea pellionella*.



Fig. 78 Distribution map of *Tinea translucens*.

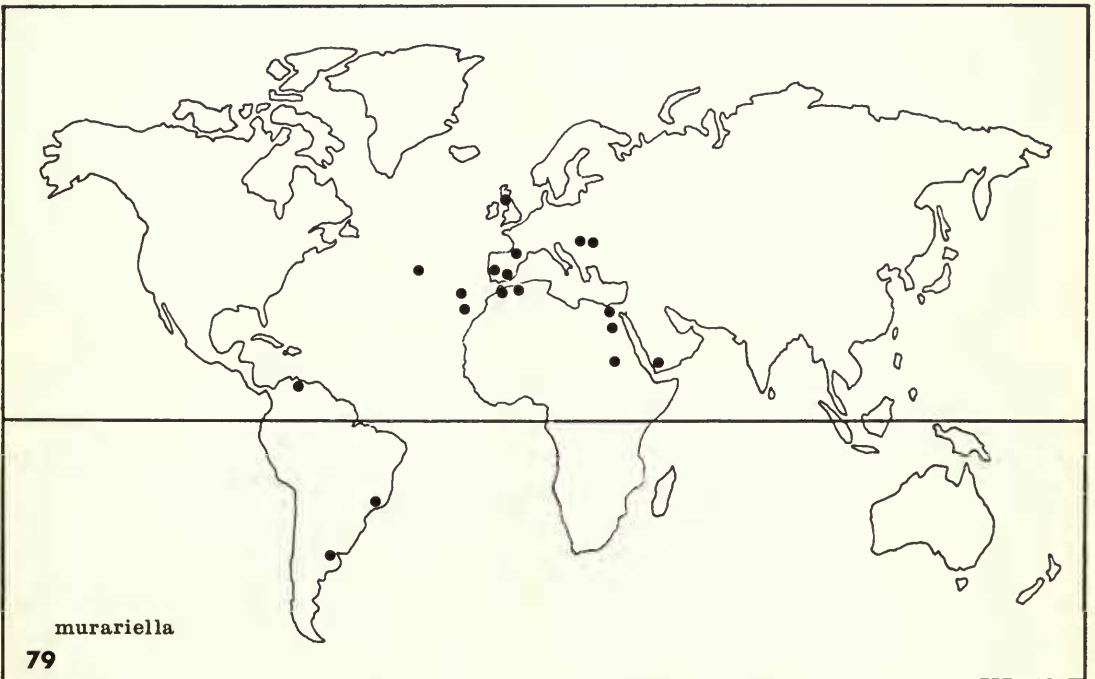


Fig. 79 Distribution map of *Tinea murariella*.

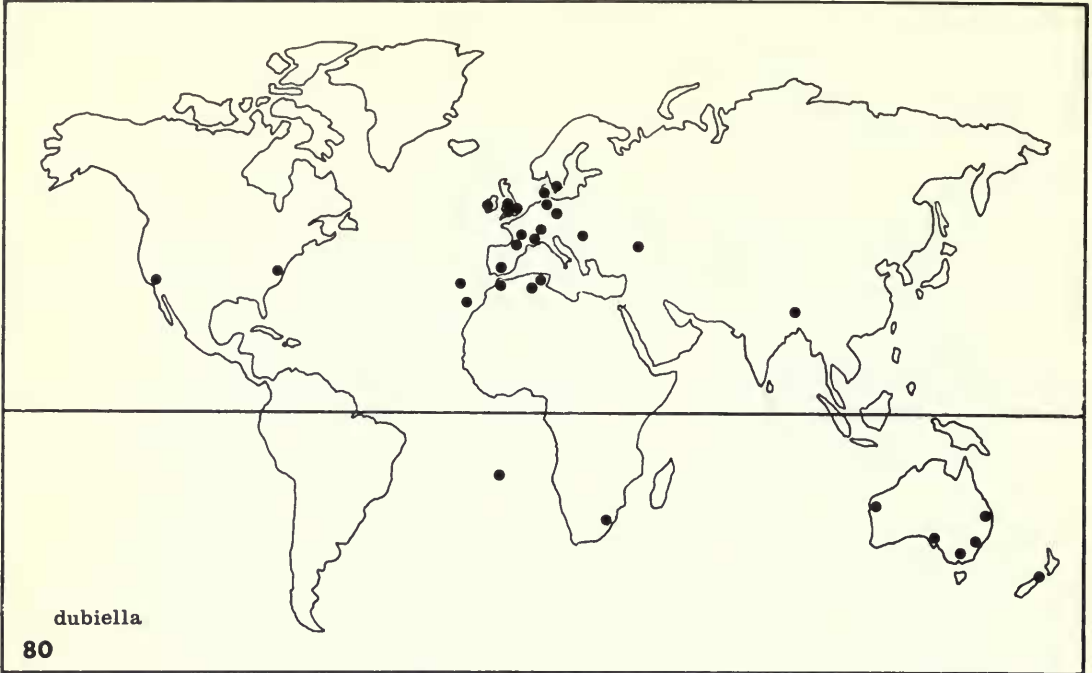


Fig. 80 Distribution map of *Tinea dubiella*.

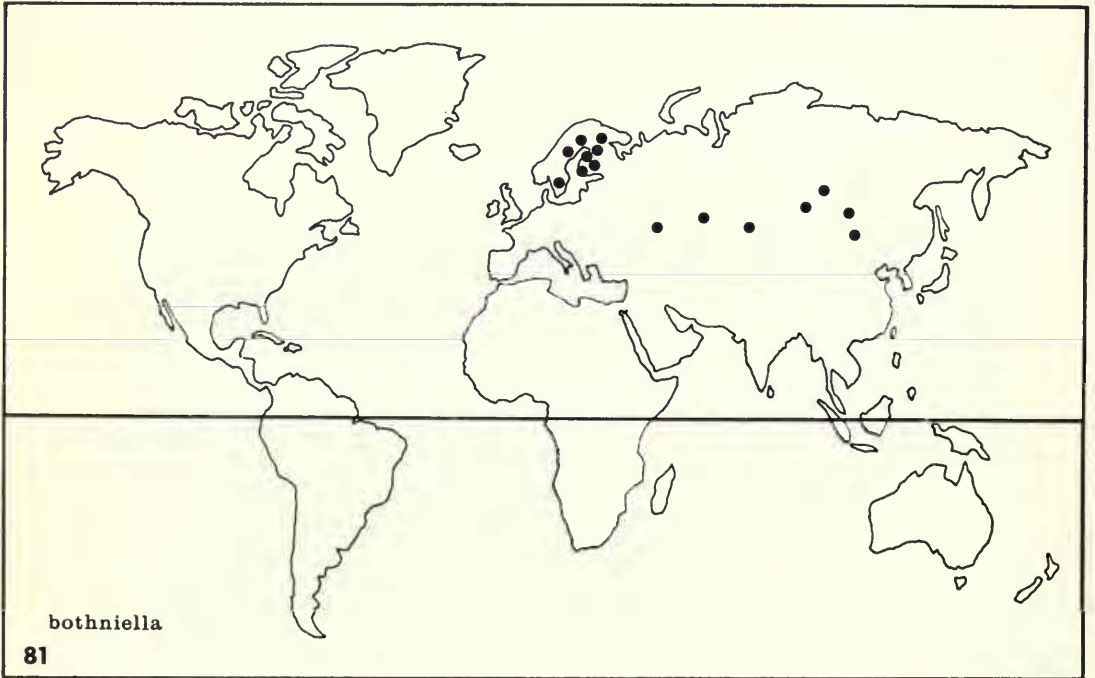


Fig. 81 Distribution map of *Tinea bothniella*.



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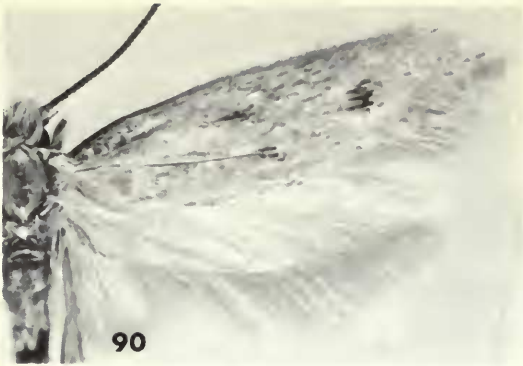


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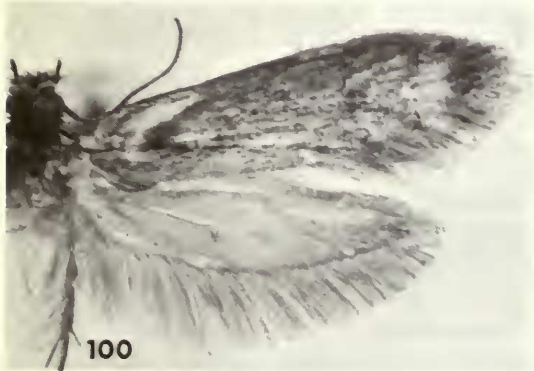


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Figs 82–89 Adults of *Tinea* species. 82, *flavescentella*, ♂, Britain; 83, *flavescentella*, ♀, Britain; 84, *roesleri*, ♀ paratype, South West Africa; 85, *pellionella*, ♂, Britain; 86, *pellionella*, ♀, Assam; 87, *translucens*, ♂, S. India; 88, *translucens*, ♀, Japan; 89, *translucens*, ♀, Britain (variant with dark scales at fore wing base).



Figs 90–97 Adults of *Tinea* species. 90, *murariella*, ♂, Tenerife; 91, *murariella*, ♀, France; 92, *lanella*, ♂ paralectotype, Britain; 93, *lanella*, ♀ paralectotype, Britain; 94, *messalina*, ♂ holotype, Italy; 95, *messalina*, ♀ paratype, Yemen; 96, *dubiella*, ♂, Britain; 97, *dubiella*, ♀, Tenerife.



Figs 98–103 Adults of *Tinea* species. 98, *dubiella*, ♀ paralectotype, Britain (gold-coloured variant); 99, *dubiella*, ♂, Britain (melanic); 100, *steueri*, ♀, Hungary; 101, *bothniella*, ♂ paratype, Sweden. Larval cases and extruded pupal skin of *Tinea* species. 102, *translucens*, ♀, Japan (dorsal view); 103, *flavescens*, ♂, Britain (lateral view).

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